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THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

· JUNE · 1916 ·

THE JOURNAL
OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

PUBLISHED MONTHLY BY
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th Street, New York

PRICE 35 CENTS A COPY, $3.00 A YEAR; TO MEMBERS AND AFFILIATES, 25 CENTS A COPY, $2.00 A YEAR.
Postage to Canada, 50 Cents Additional. To Foreign Countries, $1.00 Additional.

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Entered as second-class matter, January 4, 1912, at the Postoffice, New York, N. Y., under the Act of Congress of March 3, 1879.

THE ANNUAL MEETING

The Annual Meeting of the Society will be held in New York, December 5 to 8, 1916. *All papers for this meeting* should be sent to the Secretary not later than September 20, and those who contemplate contributing papers should notify the Secretary in advance of this date if possible. On account of the time required for all of the members of the Committee on Meetings to read the papers submitted, and because of the insistence of the membership that the accepted papers be printed and distributed well in advance of the meeting, any papers received after the date mentioned are liable to be held over for a later meeting.

The Committee on Meetings has already under consideration plans for several professional sessions. The Committee is still open to receive from members suggestions of authors of papers; as the result of the recent circular request of the Committee for such information, many valuable suggestions were sent in.

JUNIOR AND STUDENT PRIZES

The last day of this month is the limiting date for submitting papers for consideration by the Committees of Award for the Cash Prize of $50.00 and Engraved Certificate, available for the best contribution by a Junior Member, and for the four Cash Prizes of $25.00 each, and Engraved Certificate, available for the four best contributions by members of Student Branches of the Society. Manuscripts should be forwarded to the Secretary by this date.

YEAR BOOKS REQUIRED

Due to an accident, our printers are unable to complete the full order for the current Year Book, and have offered to reset the entire book at their own expense in order to print the copies needed. We are desirous of assisting them to avoid this expense, however, and have suggested to them that they offer to pay any member the regular membership price of 50c for his copy if returned at once. This they have agreed to do.

Any member not using his 1916 Year Book and being willing to assist the printer to this extent may mail his copy to the Secretary, when remittance will be sent.

THE DEVELOPMENT OF THE SOCIETY IN 1915-1916

UNDER THE PRESIDENCY OF DOCTOR JACOBUS, AND THROUGH HIS GREAT INTEREST AND ATTENTION TO ALL FEATURES

Marked progress has been made by the Society during the active season which is drawing to a close.

Besides the Annual and Spring Meetings, over 75 Section meetings at fifteen centers, and nearly 150 meetings at forty technical colleges where student Branches are established, have been held.

A Membership over 7,000

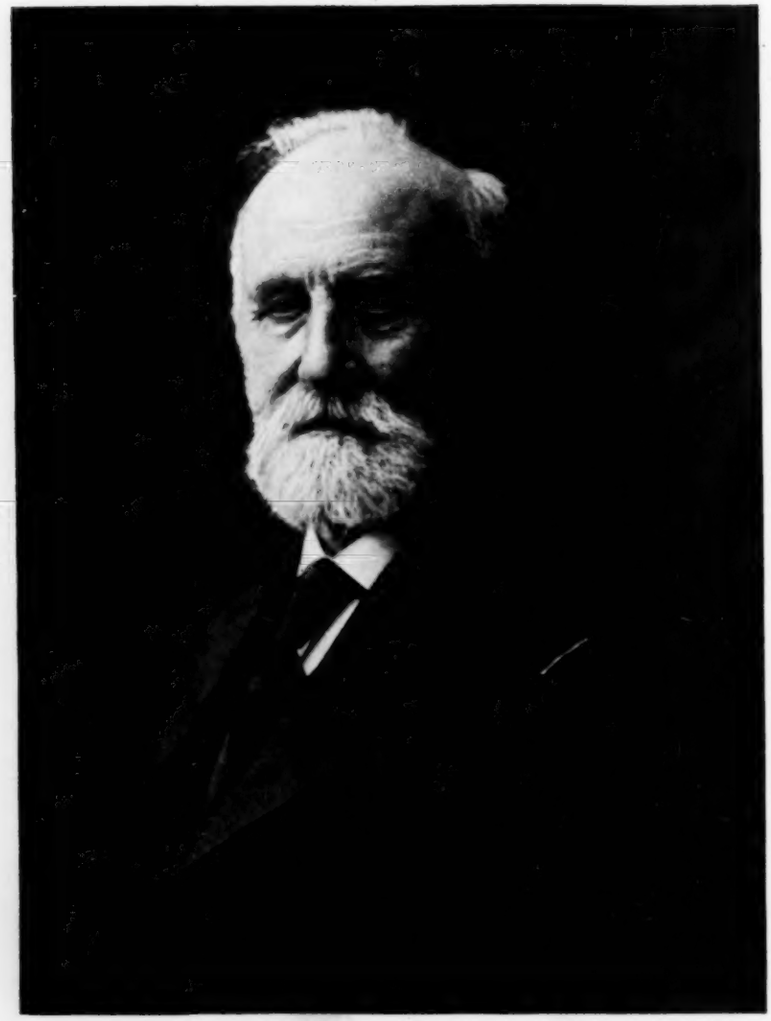
During the past month the membership of the Society has passed the seven thousand mark, having made a net gain of more than five hundred members since the beginning of the current fiscal year. In every case the strictest requirements have been met and in consequence the proportion of applicants rejected has been high.

Development of Sections

Regular meetings held at various points throughout the country greatly increase the usefulness and prestige of the Society and make membership in it more valuable and interesting to all. The increasing enrollment is making it possible to organize new Sections, and in fact this movement is now being developed in the cities of Baltimore, Detroit, Erie and Providence. Indications are that to the present fifteen Sections of the Society will be added at least five others before the end of this year.

Applications for Membership

Applications for membership filed by June 26 will be acted upon in time for successful candidates to have their membership date from October 1, which is the beginning of a new fiscal year.



JOHN EDSON SWEET
HONORARY MEMBER IN PERPETUITY
FOUNDER OF THE SOCIETY
PRESIDENT, 1884

SEE PAGE 473

INDUSTRIAL PREPAREDNESS

Discussion on Organizing for Industrial Preparedness Given at the Spring Meeting in New Orleans by Engineers from all Sections of the Country

THE paper entitled Organizing for Industrial Preparedness, presented at the opening session of the Spring Meeting held in New Orleans, April 11 to 14, by Spencer Miller, Member of the Council and one of the Society's two representatives on the U. S. Naval Consulting Board, was placed in the hands of the hands of the membership in advance of the meeting; and for purposes of reference the introduction, which was printed in the inside cover of the paper as issued in pamphlet form and which is really a synopsis of the paper, is here reproduced. This introduction will serve to call to mind circumstances leading to the presentation of the paper, as well as repeat the interrogations put for the purpose of bringing out suggestions along lines of vital import in the matter of Industrial Preparedness. The discussion follows this introduction.

A REMARKABLE RESPONSE

The discussion here published represents the remarkable result of opening a meeting of the Society to a discussion of Industrial Preparedness.

The presentation of Mr. Spencer Miller's paper at the Spring Meeting brought forth an unprecedented volume of discussion, the nature of which is indicative of the spirit among the membership of the response to the request of President Wilson for our coöperation in the patriotic work of Organizing for Industrial Preparedness.

Participation in this movement is the finest opportunity the Society has ever been accorded of directly serving our country, and it is a matter of gratification that our membership has responded to this opportunity universally.

INTRODUCTION

The engineer is active nowadays in army and navy affairs, as witnessed by the appointment of the U. S. Naval Consulting Board, the nomination of representatives for the Industrial Census, the movement for an Engineer Reserve Corps and the notable lectures on Military Engineering which are being given to the engineers of New York and vicinity.

In recognition of this trend in the engineering profession, the author raises the question for discussion of how the engineer may best serve his country as a result of the call by the Government for coöperation in organizing for preparedness. a movement which is largely dependent on engineering.

The first step in this direction was the invitation from Secretary Daniels of the U. S. Navy to The American Society of Mechanical Engineers and ten other organizations, to form a Naval Consulting Board to be headed by Thomas A. Edison, Hon.Mem.Am.Soc.M.E. This board resolved itself into committees, one of which, the Committee on Production, has as its Chairman Howard E. Coffin, Mem.Am.Soc.M.E., who formulated a plan for organizing the industries for preparedness. This led the President of the United States to invite this Society and four others to nominate a representative in each state to assist the Naval Consulting Board in "collecting data for use in organizing the manufacturing resources of the country for the public service in the case of emergency." Its immediate work will be to make an inventory of the facts necessary to be known to the army and navy relating to the resources of the nation for the supply of munitions of war in the case of an emergency or a national calamity.

The author shows that with the facts of this census properly collated we shall learn where we are weak and where strong. Not only will it be known where munitions, which include supplies of all kinds, can be obtained, but how rapidly they can be produced; to what extent America is independent of foreign countries for raw materials and manufactured products; for what kinds of munitions we have ample manufacturing facilities, and wherein we must provide means for making up the deficiency.

These and other questions are suggested by the author, and it is hoped that by way of discussion the membership will present other aspects of the situation which will have a helpful bearing on the problem of how the engineer may best serve his country.

Among the topics which suggest themselves are the following:

How can mechanical engineers consolidate their efforts in a way to oversee effectively the manufacture of munitions?

Should there be modification of standards for arms and ammunition to facilitate their manufacture?

What part should tools, gages, jigs and machine tools play in Industrial Preparedness?

What part should the textile schools take in the training of men for responsible positions in munitions manufacture, and in the testing of materials?

What should be done in the way of storing materials—nitrate and tungsten, for example—against a time of need?

Inasmuch as this paper is to be presented at the New Orleans meeting, there are certain questions relating to southern industry which may profitably be discussed. The resources of the South might supply the country with many materials needed during a period of curtailment of commerce with other nations. For example, products, and especially by-products, to be derived in manufactures of wood; in the production of sugar, cotton oil and molasses; and in the petroleum and chemical industries, especially with reference to crude oil, gasoline and sulphur.

DISCUSSION

In the main, the discussion resolved itself into two parts: What constructive means we should employ in this country in the solution of the problem of Industrial Preparedness, and what corrective steps we should take to prevent any possible repetition here of the conditions encountered at the

outset by some of the nations now in conflict in Europe. As constructive measures, many valuable suggestions were offered, such as extending the idea of the census of industries now being made to embrace a "census of men," establishing government and civil organizations to control and direct the manufacture and output of munitions, inaugurating plans whereby all manufacturing concerns should become practised in munitions manufacture by executing small orders for such material annually, etc. Corrective suggestions were made by many having personal experience in munitions manufacture for foreign governments at the present time, and included several plans for minimizing the delay hitherto inherent to munitions production on account of lack of materials specified, inability to procure gages, inadaptability of existing tools for munitions work, etc.

Discussions advocating constructive measures were as a rule general in character; these are grouped as far as possible below, and precede those suggesting corrective measures which were usually confined to particular instances and examples.

ADVOCATES UNIVERSAL PREPAREDNESS. SAYS WE NEED CORRELATION OF EDUCATION AND VOCATION

FRANK B. GILBRETH. This problem of preparedness is not one of merely preparing for war; it is also one of preparing for efficient living at any time. It is a problem of obtaining a greater general education, and a greater individual education in the same learning period. It is a problem of national elimination of unnecessary waste, of adequate general and individual effort toward utilization and conservation of our great resources. The problem comes to us as apparently original and unusually interesting to-day because of the war spirit pervading the world, and because of the glaring need for efficiency in war times. The problem existed long before the war commenced, and the results of the study of the problem will be equally useful and usable whether we engage in war or not. The experience of all Europe, the successes and failures everywhere, demonstrate that preparedness in its broadest sense means a general spirit of being ready, rather than a particular state of being ready *for war*. Just as in education it is psychologically sound to develop general abilities to a certain extent in order that special abilities may later reach their greatest height, so in preparedness it is most efficient to develop general preparedness in order that special preparedness for an emergency may be most quickly and satisfactorily developed.

This national preparedness divides itself, then, into two lines:

1 Preparedness of material things, that is, surroundings, living conditions, all of the material objects with which we deal.

2 Preparedness of people, as individuals, and as constituting society.

We must remember that in both these lines of preparation our problem here in the United States is an extremely complicated one in that our form of government, with all its advantages, lacks seriously, in many places, correlation of activities and a permanent centralized department for the planning and development of definite lines of national progress. This perhaps unavoidable lack, we must supply through a uniform and universal realization of what preparedness means and what it is for.

Much has been said already of a proper inventory of our individual equipment and resources, and a standardization of jigs, fixtures, templates and equipment of our factories and plants. I endorse the idea now put forward that this Society should be proposed as a nucleus of a permanent body to encourage and lead the way in such standardization. We must remember that such an inventory must include information as to our naval stations, founded upon measured data and recommendations of our naval officers, so that we shall judge the value of the location of our naval bases from the standpoint of their usefulness.

Let us at once apply measurement and standardization to all problems of material preparedness so that each one can do his own work with all the might that is in him, knowing that the finished products are bound to be what is required.

Efficient preparedness is not preparedness of the regular army and navy alone, or of the men available for military service alone. Nor is it the building of ships and forts only. It is preparedness of every man, woman and child in the country. Such preparedness demands, first, beginning the preparation at the earliest age available. Abroad children are trained to spend much time out of doors, and in out of door activity. Erect carriage in one country is secured at an early age by having the school child carry his books in a specially constructed bag, resembling a knapsack, on his back. Endurance is secured by out of door walks and contests. Powers of observation are sharpened through the availability, cheapness and general use of good field glasses and other stereoscopic optical devices. Thrift is installed through its practice in the homes, even to the general custom of serving of small portions at the table with the intention of passing food many times rather than to encourage the smallest portion to remain over. To take more than one wants is considered as a misdemeanor and an unpatriotic act. As a result they have, in the adult thus trained, a soldier, if such be necessary, who has strengthened his most valuable qualities by a general and not by a specific military training. In times of peace they have a citizen able to enjoy life amazingly, and to take his full share as a producer in the community, and one who realizes that the greatest individual wealth and comfort come only where there is the least waste.

Women should be prepared as well as men, prepared by a training in physical endurance, by manual training, education in household economics, in nursing and in habits of concentrating attention and following directions. It is this general training that has made it possible for women in all countries abroad to take up the work of men in all lines of activity where it is necessary.

It is not enough that the equipments and tools of the sudden need be made available. The methods of handling them must be taught in such a manner that the workers may gain not only a knowledge of the machine that makes the machines, but an idea of motion economy and of personal effectiveness.

I could run through my own experience and illustrate each point that I have brought out here by actual examples that I have seen with my own eyes in warring countries abroad, successes based on such training as this, failures caused by a lack of such training; but the feeling of partisanship so strong to-day would lead you, no matter where your sympathies lie, to evaluate the illustration as an evidence of efficiency or inefficiency *in some one country*, rather than as an argument for preparedness. The important thing is rather to re-emphasize that preparedness means not merely getting ready for war, but getting ready for real living. What should shock us is not what might happen to us in a war, but what is happening right now, while we have general peace. National waste, lack of general and specific education, lack of easy means for ob-

taining the fullest education in the vocation, for the worker in that vocation, lack of correlation! The "Spirit of 1776" is with us now, (and so are arms and ammunition of 1776). We have right here to-day the greatest opportunities that the world has ever offered. Let us not arm for a definite enemy, for tomorrow there may arise conditions that will cause us to revise our list of probable friends and probable enemies. Let us educate ourselves for individual and national efficiency. If we do this, we will be prepared, and adequately prepared, to live in peace and enjoy the durable satisfactions of life.

CONSIDERS WORK IS TREMENDOUS AND GOVERNMENT SHOULD DO IT. WANTS CENSUS OF MEN

E. H. PEABODY (written). The author asks a question which is in all our hearts in these pregnant days, when all our old belief of the certainty of honorable peace and security from invasion has been swept away, and we stand face to face with possibilities which well may make us tremble. He asks: "What may we do to serve our country?" But he answers that question with a complacency which I believe to be more apparent than real. He expatiates upon the pride which engineers and scientists should feel on having been consulted by certain officials of the Government, the eagerness with which the call was answered; and he goes on to outline the work of the Naval Consulting Board, and leads us to believe, apparently, that all or nearly all that can and should be done is now serenely under way.

But the mistake this paper makes, whether intended by the author or not, is in presupposing that the enormous work of organizing for industrial preparedness can be effectively projected and completed with the despatch which the circumstances make imperative, by the engineering fraternity of this country as represented by the engineering societies, working in the odd moments snatched from the task of making a living, without compensation and paying its own expenses.

It is indeed a satisfaction for us all to know that this important movement of industrial preparedness has been initiated and is being carried forward to far better purpose than the facilities available might promise. But the mere preliminary step of making an industrial inventory is a tremendous piece of work in itself. Can it be done by a Society like ours, or by representatives of similar societies? May we expect that even the enthusiastic army of engineer census-takers referred to by the author—in the little time available and with comparatively speaking a limited backing—may we expect that these men can satisfactorily accomplish this important work? Have we time to do it in this way? I think not.

It is our Government which must do this work, and not the U. S. Naval Consulting Board, whatever may be the enthusiasm, self-sacrifice and ability of its members, and whatever may be the help which this Society's membership at large can give; and I believe that the steps that the Society should take are those which will put pressure upon our legislators with the effect of making an organized government measure of this industrial census and all the thousand other important features which must be included in complete "preparedness against war" (to quote Mr. Garrison). It is a mistake, in my opinion, to allow the impression to go abroad that the work which the Naval Consulting Board has begun and which is being promoted by the action of the allied engineering societies, is sufficient and satisfactory, and that it will fulfill the great needs of our country. We must go deeper to make this work effective; we must bend our energies along the line of stimulating public opinion, so that our representatives at Washington will be impressed and take the necessary steps to make the whole question of preparedness a Government policy.

Besides the industrial census there must be a census of men, and every man of us must be listed in it. The Government must find out in what way the experience and talents of every man of us may best be employed in time of conflict. Every man must be assigned to his job and be getting ready for the call—whether it be to active service with the colors or in those equally important fields of supplies, without which the army and navy become impotent. Has anything been done along this line? I haven't heard of it. The Plattsburg movement seems to be the only step which has attracted public notice. It is an important and valuable feature of the problem, but it is a drop in the bucket.

The appointment of the U. S. Naval Consulting Board was an inspiration and of incalculable benefit to the country, but anything short of putting this matter of preparedness straight up to the legislative and executive heads of our Government as a National duty, is merely playing with a problem which vitally affects our very existence as a nation.

RECALLS HISTORY OF PREPAREDNESS. SAYS ENGINEERS SHOULD TAKE CARE OF BIG THINGS

CHARLES WHITING BAKER, who presented the paper in the absence of the author, said: It is interesting, I think, to recall at this time something of the history of the last half century in connection with the movement for preparedness, as it has come to be called. Those of more advanced years can recall that for twenty years after the end of the Civil War the United States did nothing in connection with national defense. While other nations were forging ahead in their military and naval forces, the United States forgot the necessity for national defense until the early eighties, when there was a sudden awakening to the wholly defenseless condition of the nation, and we began then the work of building a navy. Progress has been made—great progress, but within the last year engineers, especially, have awakened to a realization that, while we have been going ahead in a way, we have simply been following the example of some of the other nations of the world. Greater strides have been made on the other side, until we find ourselves again in a comparatively defenseless condition. It was the general awakening to that fact that led to the movement for preparedness—preparedness so that we may be able to defend ourselves.

A remarkable example of the interest the engineers are taking in this movement is given in New York City, where, in response to the call of the engineers to attend lectures on elementary principles of military engineering, given in the Engineering Societies Building, there was such a crowd assembled that many hundreds were turned away.

Regarding the industrial census, Mr. Peabody questions the wisdom of the engineers undertaking the detailed work of this census, and says that the Government itself ought to employ and pay men to do that work. I think that is a principle that could well be kept in mind, for there are so many other important things regarding which the advice of the engineer is needed, that there is no reason why the able engineers of the country should undertake the detail work of the census, which the Government itself, when shown, should undertake by its own paid agents.

The engineer can appreciate the sources of inefficiency. He has studied and made a science of many things, and the

best service that a Board of Engineers can do for the country will be to take care of the big things, and let the little things be done by somebody else.

SAYS PREPAREDNESS IS INSURANCE. ADVOCATES GOVERNMENT COMMISSION TO HANDLE MUNITIONS

OBERLIN SMITH. This subject of industrial preparedness along military lines is to my mind a very important one. A year or two ago I, in common with a great many more people, was a very strong peace advocate, and am yet. Then we were all struck dumb almost, so to speak, by this most terrible tragedy of all the world, and ideas of preparedness seem to have been forced upon us.

Writing to some of our Senators and Congressmen the other day, urging quicker action in this preparedness matter, I said, "Let us have peace at any price, even if it is a hundred battleships and a million men." It may seem foolish to spend millions, or billions, of dollars in making guns and shells and tools for their production; but is not this matter of preparedness simply one of *insurance?*

Military and naval preparedness, and the enormous expenditures involved, should go on with the utmost speed and to such an extent that there will be no danger of any nation attacking us. That is the only way to get peace—to buy it and pay for it.

And, together with military and naval preparedness goes this industrial preparedness in the making all sorts of munitions and tools for munitions, and in the furnishing of all kinds of army and navy supplies.

Mr. Miller emphasizes that machine tools for making munitions should be standardized. That work has already gone very far, but while it is going on, and munitions themselves are pretty well standardized in any one country, they are not standardized as they should be between the countries. It would be very convenient, of course, for one country to capture some of the shells of another and use them in their own guns—this may be a misfortune or a good fortune—but the fact remains that munitions are becoming more standardized.

Our tools for munitions and other military supplies should be standardized much more than they have been, so that if ever the time should come when our Government must set all its industries to work, and do it by government consent and under government protection and supervision, the matter would be easy for all concerned, and there could be almost immediate production.

Many little machine shops all over the country might have proper gages and standards, supplied by some central commission at Washington, as a bureau of the Government. Then parts could be made by the thousands and assembled in a few hours.

We can see the wonderful benefit of interchangeability of parts in some of our arsenals, automobile factories, sewing machine factories, typewriter factories, etc. By such system of interchangeability, a great many parts can now be made in a few hours which used to take weeks and sometimes months in their production.

To my mind the Naval Consulting Board is a decided step forward, and I do not see why the army should not have a similar board and the government personnel be brought together into one Commission, as I have mentioned, to handle all matters pertaining to munitions under the general direction of experienced generals and admirals.

Such a Commission could see that all the supplies for the army and navy were correlated, classified and otherwise systematized. Then we would have a true beginning of what ought to be done and what, if we now fail, we may some time find to our bitter disappointment to be one of the things that "we have left undone."

Referring again to the author's paper, one very important class of machine tools was not mentioned, namely, the presses with which brass cartridge-cases are made, up to a diameter of 6 or 8 in.,—usually not higher than about 6 in. A large number of such presses have been required in this war, made principally by four or five concerns that are equipped for such work. Hundreds of these have already been sold, and a great many more are wanted. The deliveries for such machines are now four or five months behind desired completion.

Regarding ammunition for small arms, with the bullets and powder in brass cases, less delay is occurring. Our Government at its arsenals, and also many private concerns, can turn out millions per day, and there are thousands of presses already in use for such work.

Referring again to the larger cases, the most important size is known as "three-inch" or as "75-millimeter" in France and Russia and as "18-pounder" in England. More of those are used, probably, than any other kind, and a great many American presses have been made for them. They are drawn in from six to nine operations, usually in presses giving 100 to 200 tons pressure. The blanks (disks) are cut from sheet brass, usually about $\frac{3}{8}$ in. thick. They are then drawn into cup-shape by successive operations, with annealings between. The top edge is gradually squeezed thinner until it is about 1/32 in. thick.

The later operations are usually performed with 100 tons pressure until the cases get to full length. Then they require from 1000 to 1500 tons pressure to squeeze the thick head, which is left full thickness, into the same shape as is familiar in small cartridges. These cases are nearly all being made in presses already standardized. The presses themselves are almost exactly the same as have been made for years by the different press makers for all sorts of drawing work. Thus it is possible to furnish the European governments and private parties abroad with such machines as fast as they can be made. Some of the press makers, after rushing their own

In this paper you have before you in brief outline the main features of a patriotic national engineering endeavor, unique in the world's history.

We, as engineers and chemists, had harnessed the resources of this country for the people's service, and now at the direct request of the President of the United States we are asked to make a careful inventory of these resources for our defensive line.

A successful performance of this great task to which the governing bodies of our technical societies have pledged us cannot but bring the American engineer enhanced reputation and closer future relations with the national Government.—HOWARD E. COFFIN.

Is not this matter of preparedness simply one of insurance?—OBERLIN SMITH.

shops, employed outside shops to help them out. I know of a big locomotive works which made numbers of these machines for press makers as outside work. An important ship-building concern is also helping out in the same way. There has been a great demand for such work, but this is now slackening.

These same machines would be necessary if a great many munitions were needed for our own Government. Many of them doubtless would be found in existence when needed and could be drawn upon.

Besides the presses for making cases, mostly mechanical presses, there are some very heavy machines used for perforating the steel shrapnel and other shells, although a great many of these are cut in turret lathes from solid bars. I do not know of any other substance except brass being used for the cases. We read in the papers that some European Powers are trying to make them out of steel, because they cannot get enough brass. The difficulty is, however, that when metal 3/8 in. thick has to be drawn to 1/32 in. or so, steel is very difficult to handle. Aluminum works well in the dies, but probably cannot be made strong enough.

Sad to say, millions of these brass cases are being spread over the battlefields of Europe. This makes one speculate whether brass mining will in future be a profitable industry for the future peasant-farmers in the war zones.

POINTS OUT ADVANTAGES OF PROPOSED PRODUCTION OF TOOLS IN GOVERNMENT FACTORIES

JOHN H. BARR (written). The uniform standard which is vital in producing guns and ammunition for our military forces requires a corresponding uniformity in the quality of the gages and tools for producing these. It is well known, however, that the methods and degrees of refinement in tool making vary widely among various factories regularly engaged in similar products.

The proposed agreement in the paper requires each shop to maintain corrected drawings and to construct one set of tools for such product as it is expected it may be called upon to supply. It would appear that the desired result may be more certainly attained by construction of such gages and tools in specially equipped government tool factories controlled by a highly expert staff and manned by workmen of corresponding skill. These government tool factories can construct *all* gages required and most of the important special tools. Drill jigs made in these factories can be used in any shop having suitable drill presses. Some variations exist among the machines of the numerous civil shops in the requirements as to drop forging dies, punch press dies and milling fixtures, but this will not seriously hamper the wholesale manufacture of such tools by the government tool factories. The word *manufacture* is used advisedly in this connection, for the large production concentrated in the government tool factories would be on a scale to permit real *manufacturing methods* in constructing standard tools.

The industrial inventory will afford the data for determining what particular makes, styles and sizes in machine tool equipment are available in the civil shops, and will accurately indicate the numbers of each for which tools should be provided. An alternative to reliance upon this information solely would be to have each private shop fit to its machine tools specified die blocks, vice-jaws, etc.; shipping these to one of the government tool factories to be finished, hardened and tested. Such finished tools as are not required for the peace practice of the private shops can be either stored in government tool vaults till needed, or they can be deposited with the private shops.

There is one other advantage to this proposed production of all the important tools in government tool factories which also will tend to a uniform and high standard of product. The prosecution of this high-class tool manufacture will involve some considerable production in the government shops in thoroughly testing the equipment. This will develop a large corps of mechanics skilled not only in the making of these tools, but very familiar with their use and the requirements to be met by their output. This corps of specialists would be a source from which to draw inspectors and instructors for duty in the private shops.

SUGGESTS BUREAU OF PREPAREDNESS LIKE DEPARTMENT OF AGRICULTURE, ALSO CARD INDEX OF MEN

WILLIAM KENT (written). The paper by Mr. Miller is excellent as far as it goes, and it might go a great deal further, but I understand that it is presented chiefly for the purpose of bringing out suggestions from the membership in regard to the general question of industrial preparedness. With this idea in view I beg to offer the following:

1 Why not have a General Industrial Staff or Bureau as a continuing body, out of politics, like the Geological Survey and the Bureau of Mines, to plan a national industrial campaign, doing the same service for the manufacturing and transportation industries of the country that the Agricultural Department is doing for the farmers?

2 A "form has been prepared for taking an industrial inventory." It relates chiefly to material resources, except that it includes lists of officers and directors of manufacturing corporations and lists of skilled workmen. Another form should be prepared, in order to get information for a card index of every engineer in the United States who is available for service in the Army or Navy or in any department of industry that can in case of need supply munitions, clothing, motor cars, aeroplanes or anything else that may be required by the Government. Should we be threatened with war, the first thing needed would be men of intelligence and experience who are

Let us at once apply measurement and standardization to all problems of material preparedness, so that each one of us can do his own work with all the might that is in him, knowing that the finished products are bound to be what is required.—FRANK B. GILBRETH.

It is becoming perfectly clear that the principles underlying industrial and military efficiency are the same.—H. L. GANTT.

We must go deeper to make this work (which the Naval Consulting Board has begun) effective; we must bend our energies along the line of stimulating public opinion, so that our representatives at Washington will be impressed and take the necessary steps to make the whole question of preparedness a Government policy.—E. H. PEABODY.

capable of supplying the Army and Navy with subsistence, transportation, inspection, and administration of shops, and men skilled in purchasing, contracting, industrial organization and the like. Should we be actually engaged in war, it might become necessary for the Government to "take over" any industrial establishment, any railroad, any ship, any automobile, any source of supply of natural products, such as coal mines or oil wells, and to "commandeer" the service of any man it might require for the operation of any of its establishments. For this purpose a competent board for the selection of the right man for each place is of the utmost importance, and this board should be supplied with a classified index of available men.

The form for the indexing of engineers should include name, age, nationality, health, record of education and experience, position now held, salary, positions capable of filling if the Government should command his services, position preferred, references as to character and ability, reasons, if any, why he should remain in his present position, and such other information as the Board might require.

3 In regard to gages, jigs and templates, I understand that much of the trouble that American manufacturers are having in furnishing munitions to foreign governments is due to the extreme, and in many cases unnecessary, refinement of the inspection, so that it is almost impossible to produce, with our present tools, goods that will satisfy the inspectors. Anticipating this difficulty in case our Government should need in a hurry vast quantities of munitions, we should have a Board of Inspection to review the specifications for every part of our munitions and make requirements which are reasonable and capable of being met by the available tools and manufacturing methods.

SUGGESTS LISTING MEN WHO, THOUGH INELIGIBLE FOR FIGHTING, COULD RENDER TECHNICAL SERVICE

GEO. R. HENDERSON (written). The point brought out by Mr. Miller, that for each man at the front, three are needed at home to prepare munitions of war, is a most interesting one, especially to those who, through age or physical disability, are prevented from entering the "trenches" or submarines; and it seems to me that in organizing for industrial preparedness, the engineer who may not be directly connected with a manufacturing plant should not be overlooked. There are many members acting in a consulting capacity, whose technical services would probably be of greater advantage to the Government than in digging trenches or shouldering a rifle, and I believe that these men should be listed, with their professional records, so that the very best use might be made of their services in the Navy Yards, Arsenals or other plants where mechanical skill is of the highest importance.

I would suggest to the Society's representatives on the Naval Consulting Board that they consider this feature as well as that of mobilizing factories, with their men and machines, so that all patriotic citizens would have opportunity to serve their country in time of need in a manner which would insure the greatest efficiency of the organization as a whole, and which would permit those who could not stand the rigors of active service, to perform their quota of usefulness.

ALSO ADVOCATES LISTING MEN AVAILABLE FOR WAR WORK

JAMES A. CAMPBELL (written). Members of the Society employing collectively several thousand mechanics could get signed statements from these men who would be willing in time of war to take positions in the large shell factories, or wherever machinists, etc., were required. These mechanics could be classed by their superintendents, so that firms requiring men could see from the lists the experience and class of men available. Committees could be formed for the drafting of these men so that there would be no loss of time in the production of munitions.

HAS PLAN FOR PLACING SMALL ANNUAL ORDERS FOR MUNITIONS WITH PRIVATE FIRMS AT ONCE

F. O. HOAGLAND (written). The shortage of arms and ammunition in this country, in case of immediate need, is very apparent; but it is however a fact that the great efforts in this line being made by private manufacturers would make it possible materially to change this condition at very reasonable cost, if proper steps were taken without delay.

The Springfield and Rock Island Arsenals are in good condition to turn out the .30 Springfield Army Rifles, and the Frankford Arsenal the ammunition for them in limited quantities. Arrangements are also under way to manufacture the .45 calibre automatic pistol and its ammunition at the same arsenals.

The Government has at times placed contracts for some ten million rounds of this small arms ammunition, divided between four or five private concerns in this country, but the quantities ordered have been too small to make it an object to go into the manufacture of ammunition very extensively, and no private manufacturer has made the .30 Springfield Army Rifles, nor has he any special tools, fixtures or gages necessary for making them. The conditions are about the same in regard to the .45 calibre automatic pistol as the concern which brought it out a few years ago for the Army service is the only private concern in this country equipped for its manufacture.

Judging from past experience and by the length of time it is now taking manufacturing establishments to get ready to fill orders for a product but slightly different from their regular lines, quick service is not to be expected unless several of these concerns are placed in condition to meet the demand. Orders for arms and ammunition of sufficient size to keep a small unit at work constantly should be placed with manufacturers without delay, in order to maintain the equipment in good repair and to have a number of trained workmen to form a nucleus for building up an organization in case of need.

Under the best of circumstances it takes from two to three months from the time the order is entered for the material to be prepared and the product to come through in fair quantities, even when having a suitable equipment and a trained organization.

For example, an order could be placed with each of four or five private manufacturers for, say, a minimum productin as follows, deliveries to be made monthly:

2,500 — .30 Springfield Army Rifles per month
100,000 — .30 Calibre Cartridges " "
500,000 — Each .30 Calibre Shells " "
Bullets, Priming Cups and Anvils
5,000 — Artillery Brass Cases from 3 to 6 in. calibre per month and a similar quantity and calibre of projectiles, and up to 12 and 16 in. diameter.

Automatic pistols and heavy artillery guns could be handled in the same manner.

By loading a small portion of the cartridges only, just enough to check the production of shells and bullets, a fair supply of these latter could be accumulated and carried in

stock at a cost of one-half of the loaded cartridges. Danger of deterioration of the powder or primers would thereby be removed. The present European War has brought out very forcibly the seriousness of the condition when old ammunition failed to respond at the crucial moment.

Powder making has been developed to such an extent that with a fair supply on hand at all times the loading could be carried out at the government arsenals at a rapid rate and the troops supplied with fresh ammunition. Experience has proven that the supply of shells and bullets generally controls the output.

It takes about twelve months to prepare the special equipment of fixtures, tools and gages necessary for the production of, say 100 military rifles per working day, and about half that time to prepare for 100,000 cartridges per day, even when a factory has at the start a fair organization for similar work.

A good many months additional might be spent before manufacturing difficulties were overcome and a product turned out that would pass inspection.

The government arsenals could be of great assistance in preparing the special equipment of fixtures, tools and gages, but a few leaders and workmen in each plant who are thoroughly familiar with the requirements, are absolutely necessary in order to get quick and sure response.

It is very important that if anything is to be done in this line, it is done without delay before the ammunition and arms manufacturers break up their engineering organizations, as they have about completed this class of work in connection with the contracts now on hand and are about to get down to actual manufacturing. Having had some very costly experience in getting together and training an efficient corps of engineers, they may not be very anxious to go through this same experience again in the near future.

GIVES DETAILS OF MINIMUM ANNUAL ORDER CONTRACTS PLAN

H. V. HAIGHT mentioned the following suggestions as to details in letting "minimum annual order contracts" in time of peace.

First. The Government should be the general contractor and let only sub-contracts. For example, if shrapnel shells are to be purchased, the Government should order steel from the steel mills, have it shipped to the forge shops to be forged and to the machine shops to be machined and assembled. Bullets should be ordered from the lead works, copper bands from the brass works, and so on. In this way, each man will undertake the work he best understands and the small shops will not be afraid of the work, because it will be simple both mechanically and financially.

Second. Shops should be encouraged to make their own equipment which might include even machine tools. In this way, the equipment could be rapidly increased in time of war. Of course, a set of inspection gages should be furnished by the Government but jigs, attachments, cutting tools and working gages will necessarily be special and adapted to the machine tools and methods of the individual shop. In time of war, it would be practically impossible to get these promptly from overworked tool shops or Government arsenals. Shops which are not equipped to make tools, jigs and working gages had better either get equipped or keep out of shell making, for the manufacture and upkeep of this equipment is such a vitally important part of shell manufacture that a good tool room is necessary. It will simplify the question of such equipment if each shop is given only one size of shell to make.

Third. The suggestion for a congress of ammunition manufacturers is a good one, but the dissemination of information as to methods of manufacture could be better served by arranging that manufacturers should visit each other's plants. A provision to this effect should be incorporated in government contracts. There is no doubt that a very considerable factor in the collective success of Canadian manufacturers of munitions has been the freedom with which they showed each other their shops and methods.

Fourth. As to the basis of payment, while "Cost plus a Fixed Sum" may be a fair basis for minimum annual orders, it is open to very grave objections as a basis of purchasing in quantity in time of war. The difficulty of determining the time cost is very great. The direct labor is not hard to determine but the calculation and distribution of the heavier item of burden and especially of depreciation is such that all methods may be considered mere rough approximation. The Government would need to detail an expert cost accountant for each plant. Furthermore, the cost would probably vary at least 100 per cent and it is a question if the country would be satisfied to pay one shop $1.00 and another shop $2.00 for the same work. The most serious objection, however, to "Cost plus a Fixed Sum" is that it would not give adequate incentive for low costs or large production. The Government can fix as low prices as contractors will take but, having fixed such prices, they should pay every one the same price and say "go to it." In placing war taxes, the Government might properly take a percentage of the net profits of all corporations as the Canadian Government is doing.

ADVOCATES GOVERNMENT OWNERSHIP OF DRAWINGS, GAGES, JIGS, TOOLS, ETC.

FRANK O. WELLS and CHAS. E. SMART. It seems to the writers that we do not need big armies or big navies, as the present war has already demonstrated. What we do need in the way of preparedness to preserve peace is that our machine shops be equipped to manufacture munitions of war at a moment's notice. For over two years all the machine shops in the United States have been working for the Allies, for they had practically nothing else to do, yet even to-day, new designs for jigs and fixtures for this work are upon the drafting boards and new gages and tools are being made in hundreds of shops all over the country.

We believe that the following points should be well considered:

1 That the government should own all the drawings, books of instructions, gages, jigs and fixtures, in fact all the special equipment necessary to produce munitions of war.

2 Drawings and books of instructions worked out to the minutest detail should be in the vaults in all the arsenals and navy yards, ready to be distributed to the various plants at short notice.

3 Gages, jigs and special fixtures should also be in vaults in the arsenals to be given out with the drawings and books of instructions.

4 The operations and methods of handling the work necessary to make munitions of war should be standardized in order that the time of production, and hence the cost, will be the same in all sections of the country.

5 The present arsenals should be used more as experimental stations from which the private plants could get their instruc-

tions and information. There should be a number of private plants which should be given small yearly orders for parts which they are best adapted to produce, so as to keep their organizations familiarized with the product.

It has been shown that the weakest spot in the present war is the lack of ammunition. And in speaking of ammunition, we are not including small arms ammunition, but of the 1-in. to 16-in. calibre which is used by both the army and the navy.

Below are given some statistics of the time that it would take to get prepared and to make ammunition alone.

As a conservative estimate, it would require 50 engineers, designers and draftsmen at least 50 weeks to prepare the drawings for the 17 sizes of shells now used by the U. S. Army together with drawings for gages, jigs, fixtures and tools. To produce the latter would probably require 800 men, well trained and in well organized factories, at least 5 years, calculating 300 working days per year.

This would equip 100 factories, each employing 2,000 men, capable of producing a total output of 200,000 rounds per day. Twice this amount has been used in a single day in the present war by one of the combatants.

We have not mentioned the question of aeroplanes, rifles, battleships or a large number of other important parts of equipment which must also be provided for.

This all talks of war, but what nation would dare attack us, if it knew how well prepared we were? And we, as a peace loving nation, would surely never attack any other nation, and so perpetual peace would always be assured.

RECOMMENDS A THIRD ARM OF PREPAREDNESS—TRANSPORTATION

JOHN YOUNGER (written). The author deals largely, if not entirely, with the actual production of munitions of war. He sees a nation in arms as two vast bodies, one the fighting unit, the other the producing unit. My experience has shown me the tremendous importance of a third unit, the connection between the two,—the transportation unit.

We are exporting only a small percentage of the supplies used on the European battlefields and our transportation has not proved equal to the task. The situation is like the problem of a city's water supply. Many miles away is the big reservoir: Here is the city; how best shall we adequately connect them?

The mere building of railways in our immense territory would cost us a terrible price, which would render no adequate return in peaceful times. Even if they were built, their use would be of value only in very restricted areas. Germany, France, and Russia had all built strategic railways leading to, and paralleling their frontiers, but they did not stop at this. They also built good roads. They knew that every ton of freight carried on the railroad is sometime or other also carried on a road, and they took the precaution of having the road as efficient as the railroad.

Good roads are no luxury. They are not built for the motorist, who takes a week end spin for personal enjoyment. They should be built to link up the small villages, the communities and townships with the railway and the big city. A good road opens up new country to the farmer, who can carry his produce to market at a cheaper rate. A poor farm located on a good road is often a better investment than a good farm on a poor road. A good road is an economic investment in time of peace, and it is a sign of the times that the country is waking up to the fact.

In war times the roads are the first and last links in the transportation scheme. They carry munitions to the railway, and they distribute them from it. Each link in the chain must be of adequate strength. It is useless having a perfect railway, if it begins and ends in a bog. It is useless having stretches of perfect roads in New York State, if they be totally unrelated and unconnected with each other.

Great Britain, France, Belgium, Russia and Italy have bought from us vast numbers of motor trucks. They have taken making them themselves by the thousands, and still the supply is not adequate. Figures are not available, but I would estimate that France alone, on actual military service, is probably using 50,000 motor trucks. A vast army of men is kept exceedingly busy, making and repairing her roads. Actually munitions are being put on motor trucks in the industrial centers of England, carried along the roads to the desired port, thence the truck travels by steamer and completes its journey to the base depot along the roads.

The organization of our transport demands the attention of our engineering bodies, just as much as does the mobilization of our industrial resources. The standardization of our road systems, the standardization of the controls on our locomotives and motor trucks, so that men can change from one to another with all confidence, the education and discipling of numbers of men to the principles of transportation are all matters that can only be handled by engineering executives.

There is an argument for this sort of preparedness which should appeal to every engineer whether he is in favor of military preparedness or not. It can be made a powerful lever for improving industrial efficiency.—FRED E. ROGERS.

In war, as now waged, the industrial force plays as important a part as the fighting force.—BERNARD M. FINE.

A remarkable example of the interest the engineers are taking in this movement is given in New York City, where, in response to the call of the engineers to attend lectures on elementary principles of military engineering, given in the Engineering Societies Building, there was such a crowd assembled that many hundreds were turned away.—CHARLES WHITING BAKER.

SUGGEST SOCIETY APPOINT SUBCOMMITTEE ON ORDNANCE MANUFACTURING TO ASSIST WAR OFFICE

BERNARD M. FINE (written). The subject of Industrial Preparedness, while falling within the engineer's scope, should interest us, also, as citizens. As citizens we will have to meet the cost, and one good way to reduce it is to apply consolidated engineering experience and endeavor to put the design and construction of war material upon a basis similar to what is customary in the commercial field.

The time to do this is now, and it is really within the range of the Society's work to assist the War Office in modifying its standards for the purpose.

I would suggest that the Society appoint a Sub-committee on Ordnance Manufacturing to work under the jurisdiction of some of the other research committees. The field of this committee should be so broad that they undertake to secure and present papers not only on modified standards but on methods of supervision, jig, design, etc., and anything that will facilitate manufacture in time of need, and should even go so far as to organize a volunteer force of trained engineers to act as supervisors and inspectors.

To store in times of peace an amount of material equal to the needs of war would not be wise, but in times of peace let us educate ourselves to be adequate to meet this need. In war, as now waged, the industrial force plays as important a part as the fighting force. The industrial force must be officered by men trained in the peculiarities of munitions manufacture. This is the work of engineers and the Society should make the organizing of these men its business under an Ordnance Section and keep alive the work by requesting the presentation of papers on the subject to our meetings.

PROPOSES COUNCIL OF NATIONAL DEFENSE ON WHICH ENGINEERS SHOULD BE REPRESENTED

ALFRED L. P. DENNIS[1] sent a written memorandum of a plan for the Council of National Defense which he had proposed and which has formed the basis of an amendment of one of the Army and Navy bills now before Congress. This provides for the formation of a Council for National Defense and that it shall consist of nine members, viz.: three Cabinet officers, either two or four officers of the Army and Navy respectively, three experts in special fields, and an additional member as secretary. These last four could be appointed from the outside or be detailed from various government services. By coöperation, by steady investigation, and by careful study of historical and present conditions the materials for a continuous and constructive national policy for the future would be increased.

In relation to this, he stated that it would be a pity if a Council were provided which should not include representatives of the engineering and railroad professions and which might consist chiefly of the chairmen of various Congressional Committees and other regular Washington people. Of course, officers of the Army and Navy should be members of such a Council. But the questions which a properly organized Council of Defense would have to consider are so varied and so vast, that it would be a mistake not to have representatives of the engineers of such a board to do steady, constructive work when required.

ADVOCATES COÖPERATION BETWEEN GOVERNMENT ENGINEERS AND PRIVATE MANUFACTURERS

ARTHUR G. MCKEE. We have manufacturers in considerable number who are prepared, to a greater or less extent, to make shells, rifles and armaments of various kinds, but we have no organization and no nucleus of organization, as far as I know, which can coördinate, systematize and regulate the manufacture of the different items which enter into the schedule of preparation.

I think that the biggest problem that we have now confronting us and that we would have to solve in the case of the great calamity of a war, or a threatened war, would be the preparation of such an organization to bring together and schedule the different things that make up the requirements of the circumstances. It has been mentioned that shells were held up because they did not have the timing mechanism, which was in turn held up for the lack of a certain kind of screw. These are little things, but they are most important in working up a large quantity of material, and they multiply as we get into the different kinds and sorts of equipment.

For a considerable length of time after we seriously started to prepare for a war, I am afraid that the conditions would be chaotic. I therefore think everything possible should be done in the way of preparing machine tools and all other equipment for making the multitude of necessary articles and in addition a civilian organization should be perfected and every man thoroughly trained to do his part in the ordering, inspecting, assembling, testing and delivering in the field, of everything necessary from food to munitions.

It is a very general belief among manufacturers (whether justified by the actual facts or not) that specifications for army and navy supplies are often more drastic than the circumstances warrant and that the inspection of these supplies is unnecessarily severe. Coöperation between the government engineers and the manufacturers in the preparation of these specifications and in the actual inspection work should result in the elimination of any possible cause for complaint in this respect and bring the Government, the manufacturers and their engineers into complete harmony. It would at the same time train the civilian engineers to a much greater efficiency in case war should make their services necessary.

CONSIDERS EMPLOYERS SHOULD ORGANIZE INDUSTRIAL RESERVE, AND GIVES EXAMPLE IN OWN WORKS

HARRY E. HARRIS. The program for Industrial Preparedness as it affects the engineering profession, and Industrial America as a whole, is well thought out and should be supported by every engineer and manufacturer. However, there is one point which is of vast importance and that is the outlined plan for organizing an Industrial Reserve. The labor conditions and troubles in foreign countries now at war have

To utilize the industrial resources of this country to the very best advantage, there must be a complete unification of all who participate. This can never be accomplished by the aid of a few individuals without the assistance of the Government of this country.—J. P. BROPHY.

It is the duty of employers who are patriotically inclined and willing to give their support to their country to reach their men by individual talks.—HARRY E. HARRIS.

The present war has demonstrated the tremendous advantage gained by the country that is able to start into the fight with effective equipment in sufficient quantity, and with the ability to provide at once the supplies necessary to keep the organization going.—WM. B. JACKSON.

[1]Prof. History, Univ. of Wis. Madison, Wis.

been a serious hindrance to the effectiveness of their offensive and defensive forces.

It is not only necessary to enlist the engineers and manufacturers, but it is necessary also to get the loyal support of every man who is a skilled workman and who is necessary to this country as such. Let these skilled employees know more about the plans of the Industrial Preparedness program, enlist their sympathies and obtain their pledge of willingness to be depended upon in case of emergency. Make them feel that in case America is called upon to defend herself their interests and their employers' interests are in a common cause, and that employers and men will stand shoulder to shoulder in such an emergency.

It is the duty of employers who are patriotically inclined and willing to give their support to their country to reach their men by individual talks, meeting them on a common ground, and obtaining their views and their willingness to enlist as members of the Industrial Reserve if called upon.

As an example of what may be done along these lines, a meeting of the workmen of the company with which the writer is connected has just been held, at which abstracts from Mr. Miller's paper were read and a general discussion invited; also the writer gave an impromptu talk. Men who, for various reasons, had neglected to take out their naturalization papers were earnestly advised to do all they could to get their intentions on record. An association was formed and the following resolutions passed:

"We, the undersigned, do solemnly and patriotically pledge ourselves to the defense of the United States of America in case of war against any enemy whatsoever."

"We have associated ourselves together as members of the Square Deal Industrial Volunteer Association, Employees of The H. E. Harris Engineering Co., and as native and naturalized citizens of the United States of America, and further voluntarily pledge ourselves to patriotically serve in the Industrial Reserve of the United States of America as skilled workers of The H. E. Harris Engineering Co., whenever called upon by the Government to do so, irrespective of our several religious, political beliefs, other associations, prior nationalities, antecedents or individual prejudices."

"This pledge and agreement is binding upon the Square Deal Industrial Volunteer Association as a whole, but any member leaving the employ of The H. E. Harris Engineering Co., and being released from his membership in the above association prior to the call of the United States Government, is also automatically released from this pledge."

The men evinced a hearty interest and exhibited a large share of patriotism, and demanded permission to sign at once, with the exception of one or two unskilled men who were desirous of joining either the Navy or the Army in case of war.

SAYS SOCIETY SHOULD COÖPERATE IN STUDYING CAUSES OF WAR

D. ROBERT YARNALL said he would feel very sorry to have the Society fail to include in this discussion one constructive thought which seemed to him necessary at this time. If the engineer does nothing else in his professional work, he analyzes the causes of trouble, and then, acting on this analysis, attempts to eliminate them. In this problem of industrial preparedness, commendable as it is from the standpoint of national defense, it seemed to him that quite as important at this time would be the study of and the elimination of the causes of war.

As a member of the Society, he would like to see a committee appointed to coöperate with other institutions which are engaged in the study of and the elimination of the causes of war. This question of industrial preparedness and the preparation of the industrial inventory may be desirable steps, but hand in hand with them he would like to see the Society enter into this even greater constructive work.

CONSIDERS DEVELOPMENT OF SHIPBUILDING FACILITIES AND MERCHANT MARINE IMPORTANT ELEMENTS

HENRY A. WISE WOOD[1] wrote in advocacy of the development of the shipbuilding facilities of the nation and of the merchant marine as important elements in Industrial Preparedness. Our shipping facilities should be great enough, not only to supply the great navy which we may need, but also the merchant marine which such a navy would require in times of war.

Our naval preparedness should include the upbuilding of such a merchant marine, not only that we may have it for use in war, but that in times of peace we may gather into our own hands our own overseas carriage of goods. The fleets of foreign nations built from the profits upon the carriage of our own goods will become in times of war our greatest menace because it is by means of those fleets that the trained troops of an enemy can be delivered upon our shores.

RECOMMENDS GOVERNMENT FACTORY TO CONSTRUCT JIGS, GAGES, TEMPLATES, FIXTURES, ETC.

HAROLD V. COES. It seems to me that one of the vital elements necessary for the proper carrying out of the plan is for the Government to construct in its own factory under its own jurisdiction, and in accordance with its own standards, the necessary jigs, templates, gages and fixtures that are required and that are adaptable to special or standard machine tool equipment, and either to rent them or loan them or sell them to those manufacturers who are equipped and who signify their intention to manufacture shells, rifles and other war material of this character for the Government.

I think there is no doubt that the British Government in its present crisis would have been much further ahead with its plans if it had been able to send necessary jigs, templates, gages and fixtures to those manufacturers in this country who are making munitions of war for the British Government. The jigs, tools and fixtures which rifle manufacturers in this country use were of practically little use when it came to making the Lee-Enfield; consequently it would appear extremely desirable for us to profit by this lack of foresight on the part of one of the powers now engaged in the present world cataclysm.

THE EUROPEAN WAR. SOME LESSONS DRAWN BY THOSE WHO KNEW CONDITIONS AT THE OUTBREAK

H. L. GANTT. In considering the subject of preparedness, either for peace or for war, it is imperative that we learn as quickly as possible the lessons which are being made clear to us by the developments in Europe.

In order to do this, we must ask ourselves why it is that Germany has shown so much greater efficiency, both from a military and an industrial standpoint, than have the Allies.

It is becoming perfectly clear that the principles underlying industrial and military efficiency are the same and that, if a nation is to be efficient in a military sense, it must first be efficient industrially.

[1] 25 Madison Ave., New York City.

We have talked efficiency in this country for several years, and many books have been written on the subject, but many of us feel that the actual results so far have been lamentably small; and that we should be much more nearly in the class with England than with Germany if we were suddenly confronted with her problems. It would seem, therefore, that we should find the fundamental reasons why England presented such a strong contrast to Germany, and see if we cannot learn something therefrom.

It is only a short time since England led the world in the arts, but recently Germany has demonstrated her superiority to both England and France.

We must ask ourselves how this happened. It would seem to be something in this wise: The financiers of England, feeling that wealth could purchase whatever was needed for themselves and their national life, have devoted their energies for a number of years to securing the wealth which was produced by others rather than making strenuous efforts to produce it themselves. In this attempt they have sent abroad millions of dollars to develop industries in foreign lands, which brought them great returns.

The leaders of Germany, on the other hand, not being able to exploit foreign peoples to the extent which was possible in England, turned their attention to developing their own resources, and the ability of their own people.

When the supreme test came, Germany was found to be a nation of people who, in general, knew what to do and how to do it; while the industries of England were, in too many cases, controlled by people who understood only their commercial side.

We, following the footsteps of England, have regarded financial strength as the most important strength; forgetting the comment which the ancient philosopher made to the rich man who boasted of his possessions, when he said: "What availeth all thy wealth? He that hath better iron than thou will come and take away all thy gold." In those days *iron* meant weapons. Today iron may be taken as the symbol of both weapons, and tools of industry, and the statement is just as true today as it was two thousand years ago, that he that hath the better tools is more powerful than he that hath the wealth.

The move, therefore, to get the engineers of the country working together for preparation is a most hopeful sign, for in the strenuous times in which we are living wealth may be of little more value to us than it would have been to Great Britain, but for the twenty miles of water which separated her from the Continent of Europe.

On the other hand, the power to do things cannot be taken away from us. The greater that power, the more important will its possessor become, as we realize the real meaning of the titanic contest which is now going on in the world.

The man who knows what to do and *how to do it is preeminently the engineer.* The new world, therefore, which is being ushered in by the great struggle now taking place is one in which the engineer is destined to be the supreme power, for it is becoming increasingly clear that, in future, the man who *owns things* will not be as important a factor in the world as the man *who can do things.*

CITES PRESENT WAR TO SHOW GOVERNMENT MUST COÖPERATE WITH MANUFACTURERS

WM. B. JACKSON. There is a tendency for many who have not given the matter considerable consideration to feel that the Government of the United States should place itself in a position to own its own manufacturing establishments capable of fulfilling all of the requirements of preparedness.

The sooner such an idea is rooted out the better, since at best the Government itself can own and operate only what might be considered sample establishments for the production of the materials and supplies which would be necessary in case of a serious attack upon this country. Were the United States to be attacked by a formidable foe, it would require the most intense activity of any reasonable development that the Government might have in the line of the manufacture of munitions and supplies together with the most intensive activity of every private manufacturing establishment that could be pressed into the service. The present war has demonstrated the tremendous advantage gained by the country that is able to start into the fight with effective equipment in sufficient quantity and with the ability to provide at once the supplies necessary to keep the organization going.

Manufacturing establishments do not feel safe in making broadly conceived and comprehensive plans for assisting the Government in case of trouble, owing to the possibility that the Government itself may enter their fields of activity and take away from them the business which might with propriety come to their hands during the periods of peace. It would appear that this move on the part of the Government to work up a thorough census of the industrial possibilities of our country should lead to the development of a plan whereby our manufacturing establishments may be brought into hearty coöperation with the Government with profit to both the manufacturing establishments of the country and the Government.

ATTRIBUTES SLOWNESS IN PREPARATION IN PRESENT WAR TO LACK OF DRAWINGS, GAGES, TOOLS, ETC.

FRED E. ROGERS (written). A very large munitions plant would be required to run steadily for a year to turn out the shells fired by the Allies' guns in one day on the western battle-front. To provide the millions of shells they have used has required the united efforts of thousands of manufacturing plants. But these plants had to be provided with drawings, tools, gages, jigs and fixtures and plans of operation before they could begin to produce. It has been due to their lack that Great Britain has been so slow in getting ready.

Take, for example, the manufacture of military rifles. This is a complex process requiring special skill and experience, and with the exception of our government arsenals there was, at the outbreak of the present war, perhaps not one plant in the United States properly equipped and manned for manufacturing military arms that would pass the rigid test prescribed by government inspectors. There are about 800 principal machine operations involved in making the parts of the simplest military arm, including the wood stock and hand guard. Many of these operations require special machinery and practically all the parts must be held in jigs or fixtures while machining. When we consider the fact that to provide equipment for an army of one million men, from two million to three million rifles are required, the size of the task of equipping an army of a million with shoulder guns alone becomes apparent. What the condition of this country would be in a sudden emergency, we can only guess. Judging from the experience of some of our ill-advised manufacturers who undertook to make shells, it would be one of great confusion and enormous waste.

An idea of what it means to prepare for the manufacture

of rifles may be had from the fact that there are 55 operations on the receiver[1] of a Spanish Mauser rifle and several hundred jigs are required for each unit of a plant producing 200 rifles daily, and the same applies to the gages. Data concerning their production must be prepared by experts but considerable experience is always required before satisfactory results can be obtained. That such elaborate plans pay is known from the fact that a rifle complete with strap, bayonet and scabbard can be produced with less than twenty man-hours labor.

Comprehensive plans should be prepared for the manufacture of shrapnel, high-explosive shells, cartridge cases, rifles, field guns and all the varied equipment of war. Every step of the operations should be laid down, specifying in each instance the tool and the machine on which the work should be done and the limits of accuracy required, including an estimate of the possible production. It will be a great undertaking, but how much better it will be to spend a few million dollars working out plans to provide means for industrial mobilization and rapid production than to run the risk of a complete smash-up in time of stress.

It is true that all plans, tools, jigs, fixtures and methods of operation will become obsolete when improvements in the means of production and arms are developed, as they certainly will be, but is it not better to face this certainty and be ready to reconstruct the means of production and keep them up-to-date rather than to spend several hundred million dollars in the manufacture of those munitions which themselves become obsolete and practically worthless in a few years.

There is an argument for this sort of preparedness which should appeal to every engineer whether he is in favor of military preparedness or not. It can be made a powerful lever for improving industrial efficiency. It is unfortunately true that many of our manufacturing plants are working far below their possible efficiency. They employ penny-wise and pound-foolish methods of production; their men are not trained to understand the basic principles of interchangeable manufacturing. Gaging systems are inadequate and incomplete; data on the life of gages are wanting as well as the number required for any given unit of production. There is, too, a lack of the coöperative spirit so absolutely necessary to success in any great trade or military emergency. Those emergencies will surely come to the United States, though, we trust, in the trade sense only. It will be only when we have coöperation in the true industrial sense that we can face with confidence great national emergencies.

[1] See *Machinery*, April 1916, page 655, in which every machining operation is specified and the types of machines and tools; the production per hour is given and the number of machines that each man operates, etc.

Engineers might render their best possible service at this time by suggesting such improvements in organization as would result in getting more for the money and effort expended than is at present received.—FRED J. MILLER.

The best service that a Board of Engineers can do for this country will be to take care of the big things, and let the little things be done by somebody else.—CHARLES WHITING BAKER.

Why not have a General Industrial Staff . . . doing the same service for the manufacturing and transportation industries of the country that the Agricultural Department is doing for the farmers?—WILLIAM KENT.

DISCUSSES MILITARY RIFLE MANUFACTURE IN LIGHT OF REQUIREMENTS IN PRESENT WAR

K. A. JUTHE (written). There are many different sides to the question of preparedness, and one of them is that of military rifle manufacture.

The present industrial activity in small arms or military rifles and ammunition has brought out several factors that seem to warrant a general discussion. When hurry-up orders for rifles began to come to this country over a year ago, the manufacturing interests were totally unprepared to take care of them, and they, and particularly their engineers in charge, were confronted with the unique and at the same time serious situation of being unable to secure both the number of skilled men for the preliminary work and the necessary material of the high standard required by the different governments. From the statement that orders for from 1,000 to 5,000 complete rifles per day were placed with different manufacturers, the magnitude of the problems which arose can hardly be comprehended, but the following considerations will show in which particulars we were worse off at the outset than any superintendent or engineer in charge of such work had ever thought possible.

The gage problem was one of the greatest magnitude, as it was found that it would take at least 300 first-class gage makers six months to furnish the first working set, inspector's set and the master set necessary for guns in quantities; and when 1,000 complete rifles per day is figured on, it means that the working sets must be increased from one to ten and the inspectors' sets from one to five, keeping the master set simply for reference. It was shown conclusively that among the total of practically 2,500 to 3,000 first-class gage makers in the country there was no adequate means of tackling several different propositions at the same time.

In regard to tool making, it was found that the jigs, fixtures and small tools required would take a small army of toolmakers. It would take at least 1,000 toolmakers one year to furnish tools of this kind for the output of 1,000 rifles per day. Therefore, should our government require, say, 5,000,000 rifles, or 1,000,000 rifles per year, our tool plants would be taxed to the utmost.

The suggestion put forth in Mr. Miller's paper for a central plant wherein tools and gages could be manufactured and sent out to different plants is one to which engineers should give careful consideration. No manufacturing can be started until gages have first been made. The manufacture of the gages should, however, be carried out in one plant laid out for that particular purpose and under the supervision of one head, as it would be necessary that all gages bear the same relative characteristics.

The proposition of toolmaking under central supervision, however, both as regards small tools, jigs and fixtures, is an entirely different one. Jigs and fixtures are largely made by individual concerns to suit their own particular machine tools

for rapid interchangeable production. As practically no two tool manufacturing plants have the same facilities, it is practically impossible to standardize tools for making the jigs and fixtures, and the latter would be of no value unless they were interchangeable under the majority of conditions existing.

Approximately five distinct and separate rifles are now being manufactured in this country. It would seem as though the engineers of the United States Government could design a gun, in the manufacture of which a great deal of the machinery and tools now in use could be used with equal facility; at the present writing the rifle adopted by the United States Government is so different in sizes of parts as to make this impossible.

There seems to be a necessity for a standardization of parts, or, at least, for some method whereby tools could be made up and jigs and fixtures made suitable to fit the conditions existing at each of the large manufacturing plants now engaged in similar work. These could be kept in stock, and as soon as occasion required they could be handed over and manufacturing could proceed with practically no stop, excepting the necessary adjustments and preliminary inspections.

This is only a rough outline of what the writer has in view insofar as the situation for actual manufacturing is concerned. There is ,however, another point pertaining to getting the raw material into shape for an actual manufacturing proposition. The materials specified by each government vary largely in analysis and physical requirements. In some cases such requirements are more than a ballistic test has shown necessary as a factor of safety. It is easy by heat treatment to get steel of a certain analysis to meet the required physical specification, but manufacturers have a specification of their own which reads that all steel furnished must possess machining qualities within certain limits. At the present writing, the steel mills are doing splendid work in furnishing steel to requirements, but when an overcrowded condition, careless handling or unknown quantities creep in amongst the billets we are confronted with what we term a "dirty steel," and although all requirements as to physical qualities can be met, drilling and rifling a barrel becomes a serious and heartbreaking problem, as it is impossible to perform these operations satisfactorily if any dirt or a slag deposit is encountered in the center of the steel.

The following factors have already been thoroughly demonstrated as entering into the making of a standard high explosive rifle:

1 Analysis of steel necessary.

2 Manufacture of such steel with minimum waste

3 Forging or rolling of rifles without harmful effects to the steel.

4 Heat treatment of rifle barrels to give the high physical properties required with a high degree of machining qualities. The small parts of the rifle can be readily taken care of as far as hardening and heat treatment are concerned.

Also the following matters need very careful consideration, especially as they are not at present in a very satisfactory condition:

1 Design and standardization of parts

2 Design and manufacture of gages

3 Design and manufacture of interchangeable tools, jigs and fixtures

4 Supply of a proper quality of kiln dried lumber for stocks.

POINTS TO WASTE OF LESS COMMON METALS IN WAR AND CITES REMEDY IN BILL OF MATERIAL

PERCY E. BARBOUR[1] contributed an interesting account of the prodigious waste of the less common and semi-rare metals in the war. Cartridge brass for use in making cartridge cases must necessarily be composed of the best brands of copper and zinc because the drawing of cartridge cases is the severest test to which such metal can be put. But specifying high-grade copper, zinc or brass for everything required in military work is wholly uncalled for.

For example, in the manufacture of shells the British have been using a brass plug for closing the opening in the nose of the fuse temporarily between the time when the shell is completed ready for shipment, and the time of its fusing prior to the action in which it is required.

The 4½-in. high-explosive shell manufactured in Canada has a brass plug which weighs 10½ oz., is very carefully machined and threaded and screws into the nose of the projectile easily by hand, but has a square recess in the top for the insertion of a square-end wrench in case it cannot be unscrewed by hand. When the shells are fused in the battle area, these plugs are taken out and thrown away and are a total loss. If 1,000,000 shells are fired in one engagement in one day, some idea can be formed of the prodigious waste of war, so far as this item of copper and zinc is concerned. The same shell also has a copper rotating band near its base and has a time detonating fuse of brass in its nose, both of which are converted into hundreds of pieces on the explosion of the shell.

There is no valid reason for making these temporary plugs of the most expensive material available, and evidently this has dawned upon those at the head of the munitions manufacturing department in England, because wood plugs are now being used in place of the more expensive metals. Recently a manufacturer of war material was approached for a bid on a large number of these nose plugs. His figure, scaled down to the minimum, was more than a million dollars. This price being unsatisfactory to the representative of the foreign purchaser, the bidder made an alternative figure, which was less than 1/400 of the first, if he were allowed to make the plugs

[1]Eng. & Min. Journal, New York City.

The biggest problem that we have now confronting us and that we would have to solve in the case of the great calamity of a war, or a threatened war, would be the preparation of an organization to bring together and schedule the different things that make up the requirements of the circumstances.—ARTHUR G. MCKEE.

It is becoming increasingly clear that, in future, the man who owns things will not be as important a factor as the man who can do things.—H. L. GANTT.

Your action is a patriotic one, and a needed step in the right direction, for it will show us some of our weaknesses and give us a better idea how to remedy our defects.—MAJOR W. GOFF CAPLES.

out of wood. The turning of these plugs from wood and the cutting of a satisfactory thread on them is said to be one of the most difficult manufacturing details, but they are now being turned out and used and so far as is known with perfectly satisfactory results.

We have it from an authoritative source, that one reason why the Russian supply of ammunition was so slow in coming forward early in the war was because, prior to the exigencies of the recent campaigns, the Russian specifications required that all of their projectiles be nickel-plated and neither the time nor the nickel was available for fulfilling these requirements on the vast number of shells that were being expended on the battle front. Nickel-plating the projectile of course reduces the wind resistance, but it is probable that grinding and polishing, which can be done so cheaply by American methods, would accomplish the same result.

As an effective means of reducing these wastes of valuable materials, which, while they are often minor items, yet in the aggregate are very large, the writer suggests, quoting from an editorial in the *Engineering and Mining Journal.*

The army general staff should determine the number of men to be put into the field in the worst possible contingency. It should draw up a complete bill of material for the supply of such an army, which, with the specifications, should then be referred to the U. S. Naval Consulting Board, representing the engineering societies, and by it should be cut up and distributed among the engineering societies—the metallurgical parts to the metallurgical engineers, the mechanical parts to the mechanical engineers, the chemical parts to the chemists, and so on. Those bodies would then subdivide things among their specialists. They would scrutinize the specifications, finding out whether certain things likely to be troublesome or costly were prescribed by reason of necessity or by reason of tradition; they would suggest substitutes and improvements. Having determined what was really needed, they would formulate plans for the supply of it, making a survey of the industries, listing industrial plants, etc., and recommending steps for the filling of gaps.

ILLUSTRATES NECESSITY FOR STANDARD MACHINE TOOLS AS SHOWN BY WAR. ENUNCIATES PRINCIPLES

L. P. ALFORD (written). Mr. Miller, in his excellent outline of the need of organizing for industrial preparedness, points out that consideration should be given to machine tools from several aspects of their design and supply. The importance of these machines in time of war is strikingly proved by comparing the machine-tool exports from the United States for the calendar year 1915 with the record of the best previous year in our history. In round figures, $42,000,000 worth of machine tools were shipped during 1915, while the highest preceding yearly record was about $16,000,000 worth.

But little is known in this country of the methods that Germany has employed to build and maintain the machine tools necessary to produce her munitions of war. On the other hand, there is considerable information available in regard to the methods employed by Great Britain and France. Thus it is from the experiences of these latter named countries that we can formulate the principles of action to govern the design, purchase, production, and distribution of machine tools which must be carried out in preparing for a national emergency of war.

The machine tools shipped abroad during the past 20 months analyze into three general classes. *First,* simple, plain machines that were either standard with certain manufacturers before the outbreak of war, or have been designed and built under the stress of the tremendous foreign demand. *Second,* regular machine tools of a more highly organized grade, particularly automatic machines that were the standard product of some manufacturers prior to the outbreak of war. ***Third,*** special machine tools developed for some operation or series of operations in the manufacture of some particular detail of munitions, and grouping into: (*a*) lathes for the outside turning of shells; (*b*) lathes for boring shells; (*c*) lathes for waving, grooving and undercutting shells. The first class comprises by far the greater volume of the exports, and simple lathes are the predominating machines. In like manner, lathes predominate in the third class.

The methods adopted by Great Britain, France and Russia in buying these machine tools need brief consideration. The early orders were placed by European machine-tool agents who had handled American machine tools for years and whose knowledge of the business gave them the first entrance into the field. These dealers' contracts were followed by others given by special agents or government commissions who came over to this country during the first year of the war. These orders brought about a condition of scarcity of machine tools in the United States, and at the same time filled all the regular machine-tool building plants with such a volume of business that deliveries in many cases have been seriously delayed. The third class of buying has been by government commissions in shops making high grade machinery other than machine tools, as printing presses and woodworking machinery, and in general have been for machines of the third class previously mentioned. Their buying has been most ably managed, and the results of their work has been more uniformly successful and satisfactory than that of any of the private buyers.

The private buying, that is, the buying done by machine-tool dealers, can be roughly divided into three periods. During the first period simple lathes and turret machines were bought almost exclusively. The demand during the second period was for grinders, drilling machines, and millers. The demand during the third period was for planers, shapers and toolroom machinery.

After learning from the hard school of experience, it is now realized that toolroom machinery should have been bought during the first period. The reason is obvious, for such machines are needed to produce the jigs, fixtures and gages which are the necessary accompaniment of machine tools for duplicate production.

In case of war with a first-class power, the United States would unquestionably need to add an enormous number of machine tools to the present equipment of her machine shops. Based on the record of the years immediately preceding the outbreak of the European war, the normal surplus of machine-tool production of the United States, as represented by the amount shipped abroad, has a value of about $15,000,000. This supply would naturally be kept at home, but in addition thereto we would have to draw from the industrial nations of Europe, provided we were not involved in a European war. This buying would have to be done by some organization not now in existence, for the reason that there are only a few agencies in this country that market European machine tools here.

Thus, the European buying for the United States would have to be placed in the hands of experienced men, perhaps civilians representing both builders and users. The present British Ministry of Munitions with its sub-committees might well form a model for the American organization charged with the duty of buying machinery abroad. There are facts that tend to prove that the work done by the British Commission

has been most efficiently handled, and has brought excellent results. This is an experience well worth careful weighing.

As already stated, but little is known of the conditions that have surrounded the machine-tool industry in Germany during the war. However, at the outbreak of war edicts of the Ministry of War placed a prohibition upon the exportation of machine tools as one of the items in a list of articles that might be of value to the enemy. As the war progressed, the Ministry formed two committees, one the War Raw Materials Committee, and the other the Industrial Committee. These Committees have controlled the machine-tool building industry as well as other German industries. They have directed what machines should be built and where they should be built, have handled the supplies of raw materials for machinery building, and have arranged for the distribution of the new machines as well as other machines that could be released from their regular employment.

It is reported that France mobilized the machine tools of the Republic as one of the early war measures. The purpose was to bring together the machine-tool equipment into units of such a size that manufacturing could be carried forward expeditiously and efficiently.

Thus from the experience of Great Britain, Germany and France, the necessity of controlling the supply and distribution of machine tools is evident in case of war between first-class powers.

No exact estimate can be given of the number of machine tools that might be immediately available in Germany in case there should be an emergency demand from the United States. A careful estimate for Great Britain, however, is that under normal conditions there are some 1,200 to 1,500 lathes in the stocks of dealers and builders at any normal time. In any event, it is fair to assume that the stock of machine tools in the possession of dealers and builders in Europe would not be very great, and, in fact, would be a very small factor in the number that we would be liable to need. Accepting this situation as a starting point, a decision can be made as to whether the nited States should buy standard machines regularly manufactured abroad, or order special machines particularly adapted to our own needs.

Mr. Miller has pointed out the necessity of standardizing machine tools. If they are to be standardized for our own makers and needs, it follows that the machines brought from Europe should be uniform with those produced here. Without question, machine tools should be standardized, and the motive of industrial preparedness should be sufficient to inaugurate the study and work of standardization at once.

From the experience of the allied nations in purchasing machine tools during the past 20 months, it seems justifiable to lay principles for the standardization and procurement of machine tools in organizing for American industrial preparedness. The first of these are:

1 Organize at once, in skeleton form, an industrial committee to control the standardization, design and preparation of machine tools for the production of American munitions.

2 Through joint action of this committee, The American Society of Mechanical Engineers, and the National Machine-Tool Builders' Association, standardize the details of regular machine tools and design whatever additional special machine tools may be necessary for the rapid and economical production of American munitions.

3 Immediately on the outbreak of war, prohibit the exportation of any machine tools from the United States.

4 Immediately on the outbreak of war prohibit the importation of any machine tools into the United States except under license and control of the committee mentioned under 1.

5 Order all machines abroad through this committee or its representatives in the capitals of Europe, and entrust these men with the responsibility of securing the desired deliveries and quality.

6 Order no machine tools abroad except to standardized American designs, either for the complete machine or the essential details as the committee may determine.

The subject of standardization of machine tools was thoroughly talked over at a convention of the National Machine-Tool Builders' Association a few years ago. However, as that body is a business rather than a technical organization, no efforts have been made to bring about uniformity. The suggestion has been offered that this work of standardization should be done jointly by The American Society of Mechanical Engineers, the Industrial Committee outlined in this paper, and the National Machine-Tool Builders' Association. I believe, however, our Society should initiate and prosecute the work.

Subsequent to the presentation, Mr. Alford presented a motion, which was duly seconded and carried unanimously, that the Council be requested to consider the advisability of appointing a Standardizing Committee for Machine Tools, in view of the necessity for standardizing our industrial resources for war.

FROM PERSONAL EXPERIENCE IN CANADA SHOWS NECESSITY FOR MODEL MUNITIONS PLANTS

CHESTER B. HAMILTON, JR. (written). The writer is too busy right now producing munitions to go into this matter as it deserves, besides being rather too close to the subject to get a proper perspective. There are, however, several matters which might be added for consideration from the experience of one who has been through this strenuous war time organizing.

1 During the period immediately following a declaration of war there would likely be a considerable interruption to business with consequent disorganization. Following this the shops that got started to work on war materials first would promptly gather to them the best men from their neighbors. This would leave some plants in a very bad condition. The writer has noted this especially in the case of leading hands and sub-foremen, some shops being practically stripped. Means should be provided to compensate for or offset this.

2 Somewhat similar to the above is the necessity for providing understudies for the more important men in the plant. This is generally appreciated, but its need is felt a hundredfold in war time.

3 A skeleton of an inspection organization would be provided in advance by a wise government, thus eliminating innumerable troubles that arise when a lot of slightly informed and hastily got together inspectors are given power.

4 One or more small model plants should be maintained for each of the principal classes of munitions and should be worked actively under an approximation to war conditions. The size should be the minimum economical unit for the machinery involved. One of the greatest hindrances to Canadian munition manufacturers in getting started was the lack of an efficient and up-to-date sample plant. We had no idea at just what speed the different operations could or should be performed until we found out by months of work.

5 In placing "Minimum Annual Orders" or other form of government subsidy for preparedness, attention should be paid to the necessity for room for plant extension. A certain proportion of the subsidized firms will fail to make good when put to the supreme test. Others will do exceptionally well. It is absolutely necessary that those succeeding promptly, due to superior organization or brains, should enlarge and extend, again and again, until they have taken up and carried the load of their weaker fellows.

6 Following on the above two other points must be considered:

a Financial assistance for plant extension should be promptly furnished to those shops which have made good in production and efficiency.

b There should be some central control over employment to prevent one shop unnecessarily stealing operatives from another, as its necessities increase, instead of training its own.

7 Payment for munitions should be made partly in the form of government bonds. If some of these were in small denominations, employees would likely invest in them. Perhaps I am astray in this last suggestion. I can only speak of those I know. Our best are Scotch.

8 As to a profit limitation, and payment on a "cost plus" system, why not consider something akin to the ordinary premium or bonus systems of wage payment, by which a contracting firm would get a greater percentage return, or greater profit per unit of product, in proportion as the cost per unit was reduced by efficient production.

GIVES EXAMPLE OF RAPID ORGANIZING FOR MUNITIONS BUSINESS IN PLANT IN SOUTH

HARRINGTON EMERSON. I would like to tell you of an experience that one of my friends had with a munitions plant he organized just a year ago. This plant was in the South, not in the North. There were no buildings; no machines; no employers. My friend told his assistant that they would subdivide the work; that he himself would look after the equipment, getting the buildings up and securing all the necessary machinery, much of which had to be designed, and that it would be the assistant's duty to have the men ready to go to work when the time came.

The assistant sulked at first, as he had no desire to be sidetracked in that way, put on the job of employing men when he had expected to do executive work; but the head of the concern said to him: "You seem to miss the whole point. You don't know that you have the biggest job that was ever offered to any man in connection with this work; you don't seem to know that you have got to examine and list for this plant over 20,000 men in order that we may pick from them 2,000 of the kind that we need. What I expect of you is that when I call for the men you will have them ready."

That woke the young man up to the importance of the undertaking assigned to him. He went out into the country, north into Pennsylvania, to Harrisburg, Reading, Lebanon, Hagerstown, and south into North Carolina and as far as Georgia; and he collected the names of a great number of farm boys, boys who knew how to handle tools, to mend harness, repair farm machinery, sharpen a ploughshare, do carpenter work about the house, boys that were versatile if as yet crude mechanics. These boys were investigated as to their ancestry for two generations back, and owing to the war difficulties they applied the principle of selection to a greater degree than I have ever seen it applied before anywhere, except, perhaps, for admission to West Point and to Annapolis.

These boys were there when they were wanted and were brought into the plant when needed—some 1,600 in all. The foremen had been told in advance what they were to do and they were prepared for the recruits. They gave to each one, two or three days of special instruction, each foreman having been obliged first, to demonstrate his own ability to run each machine in his department and to turn out satisfactory work, the plant having been run by the foremen on a small scale for a few weeks before the recruits came in.

The boys were put on the jobs, and in less than a week they were "making the foremen hustle," as one of the foremen told me, and the manager told me that in all his experience of many years as the executive head of one of the largest plants in the United States, he had never brought together so good, so able, so efficient a set of workmen as he had in that plant within three months. This shows there is abundant opportunity to find in America the raw material if we go about it in the right way.

Should we be actually engaged in war, it might become necessary for the Government . . . to "commandeer" the service of any man it might require for the operation of any of its establishments.—WILLIAM KENT.

There is abundant opportunity to find in America the raw material (to produce efficient workmen) if we go about it in the right way.—HARRINGTON EMERSON.

In case our Government should need in a hurry vast quantities of munitions, we should have a Board of Inspection to review the specifications for every part of our munitions and make requirements which are reasonable and capable of being met by the available tools and manufacturing methods.—WILLIAM KENT.

ALSO DRAWS LESSONS FROM CANADA REGARDING MUNITIONS MANUFACTURE

RALPH E. FLANDERS. During the early part of the European war my firm was quite familiar with conditions in Canada. There were a number of points in connection with our experience which would be useful on our side of the boundary.

One of the great difficulties was in getting gages. Mr. Wells treats of this subject in a written discussion, so I will say nothing about it, except to indicate that the difficulty was extremely serious, accounting in some cases for delays of many months. The rapidity of wear of gages in constant use was also much more severe than had been expected.

The second difficulty was the lack of coördination in the furnishing of materials and supplies. Conditions were the same

as if in a manufacturing establishment one department should get ahead of another. The makers of shell bodies, for instance, were sometimes months ahead of the makers of fuses; also fuses were held up for a small screw. It will be necessary to pay particular attention, possibly by means of a special committee, to this matter of coördinating the production of the separate parts.

An exceedingly favorable thing in the Canadian manufacture of munitions was the hearty coördination of all the firms engaged. There were no secrets in their shops. It was a requirement of the Shell Commission that every one who desired to engage in the manufacture of munitions should be privileged to see what every one else was doing. While the whole country was ignorant and unprepared at the start, in a remarkably short time the necessary information was spread to every corner of the Dominion.

Conditions are quite different in our country where munition manufacture is kept more or less secret in private plants. This is even the case at the present time at the Frankford Arsenal, unless conditions have changed recently. This is a bad condition. It is not necessary that the arsenals should be thrown open to every one, but it is advisable that every one who may be called upon to manufacture munitions should have free access to the government arsenals.

Canadian experience would indicate the impracticability of standardizing methods, at least, so far as the making of shells is concerned. The demand is so tremendous that the problem cannot be approached from the ideal standpoint. Every imaginable kind of tool has to be used. For instance, the finishing of the inside of a shell may be done on the engine lathe, the hand turret lathe, the automatic lathe, the drill press or on special machines made for the purpose. It would be folly to confine the doing of this work to any one machine and leave the resources of the other machines untouched. I am inclined to think we should go slowly in the matter of standardizing too closely the processes of shell making, or we will greatly cut down our rate of production.

Another interesting point is the possibility of improvement in design. There are two sides to this subject. The machine shop man who undertakes munition work meets a large number of apparently foolish restrictions. After he understands the problem better he finds that many of these restrictions are not foolish, but are necessitated by the unusual requirements of the case. There are some directions, however, in which it is possible for the ordnance designer to come more into line with the manufacturer. As an example there may be mentioned the question as to when the shell should be heat-treated. The classical method followed on the English shell and by our own Government is to treat it in the blank immediately after forging. Under pressure from the manufacturers it has been found possible, so far as the English shell is concerned, to leave the heat-treating until the final finishing operation on the outside, thus greatly increasing the output of shells with a given equipment. This would be worth while looking into for our own work.

Mr. Miller speaks of the possibility of paying for munitions on the basis of cost plus a fixed percentage of profits. This is exceedingly important. There must be no excessive war profits to American manufacturers on our own government work. There are rumors of excessive profits even in well-governed Canada, and conditions would be certainly as bad in this country unless the Government firmly controls the situation from the start. Something in the line of a standard method of accounting should be worked out defining the method of figuring depreciation and other items of the overhead, but leaving the details of the calculations to follow the regular accounting systems of the manufacturer. These requirements could be made quite simple and could be easily taken care of.

If I may be permitted, I would like to speak a word on the general problem from a viewpoint which strikes me as very important. We are proud of our democratic form of government, and believe in it thoroughly, but we nevertheless see its disadvantages when compared with a highly centralized government, particularly when carrying on a war. It is sometimes discouraging to read reports of congressional investigations, recriminations and changes of policy with relation to army and navy matters. The question arises whether we have not here a splendid opportunity arising from the fact that the various engineering societies are continuous organizations, not subject to periodical overturns. If we can get into a position of close sympathy and coöperation with the continuous organizations of the army and navy, it may be possible to formulate and develop lines of policy that will be permanent, consistent, systematic and thorough, even though administrations and parties come and go. Then this industrial preparedness will become a normal, continuous thing, little affected by the unfortunate cataclysms that go with our democratic form of government, using "democratic" in the larger rather than in the party sense.

DISCUSSES PRODUCTION OF FUELS, ACIDS, ETC. ENUMERATES RESOURCES OF SOUTH

C. S. WILLIAMSON, JR. Mr. Miller says that "an interesting and profitable inquiry might be directed towards securing fuel other than gasoline . . . ," and that the resources of the South "might supply the country with many materials needed during a period of curtailment of commerce with other nations."

The production of grain alcohol from saw-dust and waste-wood is beyond the experimental state. Grain alcohol has been and is being produced on the commercial scale economically, possibly as cheaply, if not more cheaply, than from molasses or grain. Two things are necessary for more extensive utilization of alcohol, hence more extensive manu-

When we consider the fact that to provide equipment for an army of one million men, from two million to three million rifles are required, the size of the task of equipping an army of a million with shoulder guns alone is apparent.—FRED E. ROGERS.

One of the greatest hindrances to Canadian munition manufacturers in getting started was the lack of an efficient and up-to-date sample plant.. We (in Canada) had no idea at just what speed the different operations could or should be performed until we found out by months of work.—CHESTER B. HAMILTON, JR.

It is from the experience of Great Britain and France that we can formulate the principles of action to govern the design, purchase, production and distribution of machine tools in preparation for a national emergency of war.—L. P. ALFORD.

facture (1) its successful use in motors, (it has a heat value two thirds that of gasoline); (2) tax-free legislation which will permit its sale for specific uses in manufacture in the undenatured condition.

Alcohol plays an important part in the manufacture of explosives and also medicines. Because of the lack of a tax-free alcohol, however, a great many of our medicines cannot be manufactured on an economic scale, to say nothing of many other manufacturing processes involving the use of a pure alcohol.

We are producing explosives to-day for the fighting countries, but in doing so, we are employing nitrate of soda (as a source of nitric acid), wholly imported from another country. If we were thrown upon our own resources, we would have a reserve of 25 per cent of the required amount of nitrate of soda available for the manufacture of explosives in the States. We import 1/5 of the production from the Chilean mines. We use 75 per cent of this amount in the manufacture of nitric acid and explosives, the other 25 per cent being left for the fertilizer and other industries. We do not, at present, make nitric acid in this country (with the exception of a few small units in industries devoted to other processes and a small experimental plant at Nitrole, S. C.) except from Chilean nitrates, and not an explosive can be made here without the use of nitric acid.

Nitrogen in an available form is necessary food for both animals and plants, which adds to the importance of having a source of manufacture non-dependent on Chilean nitrates.

Synthetic nitric acid, on a commercial scale, had its birth on American soil, but because of withdrawal of financial support, the life of Bradley and Lovejoy's plant at Niagara was short. Had they had governmental support, we would be producing nitric acid from the atmosphere today, instead of being lookers-on at Norway and Sweden, Germany, and others who are doing so, and dependent upon our importations of Chilean nitrates. At the outbreak of the European war, Germany had within her borders 660,000 tons of nitrate of soda; during 1914, up to August 1, she imported 800,000 tons from Chili, and she captured at Antwerp possibly 200,000 tons more. Yet in spite of these quantities which were used up during the first few months of the war, she has expended since then in development of her nitrogen industry practically $100,000,000. Nitric acid is the means to every explosive, to every dyestuff (coal tar dyestuffs), and to a great many other materials, and available nitrogen is the means to the life of every animal being.

As to the resources of the South: regarding the fuels, we have oil, gas, lignite, coal, sources of alcohol, untouched beds of peat; regarding explosive materials, we have cotton, wood pulp, can and do produce coal-tar products, and materials for glycerine; as regards munitions, we have iron and steel, manganese, aluminum, copper, zinc, and lead; we also have cement materials, timbers, building stones, etc., for housing plants; regarding dyestuffs, we have the coal out of which to make the raws and intermediates, we have the petroleun out of which to produce intermediates; as regards textiles, we are already spinning 3/5 of the cotton spun in the United States; as regards forest products, we have in Louisiana alone the largest standing body of long leaf yellow pine in the States, and are unsurpassed only by the Pacific states and Idaho in quantity of timber. I mention yellow pine, especially, because of the naval stores industry and of the demonstration beyond a question of the practicability of manufacturing paper and paper pulp from it; two plants have for some time been successfuly operating on yellow pine, one at Moss Point, Miss., and one at Orange, Texas. Another forest products development is the tanning industry, which concerns the supplying of shoes for an army. In the eastern part of Tennessee, this industry has found considerable development within the past year and a half. We have large quantities of hard woods and tanning woods in the South.

As regards water power, in the State of Alabama alone, there is listed 1,000,000 horsepower capable of development, 20,000 of which have been developed. Other water powers of the South are yet unmentioned.

For every dyestuff and explosive, heavy chemicals are required. For the manufacture of heavy chemicals, we must have sulphuric acid; for sulphuric acid we must have nitric acid (except by the contact process). For the manufacture of nitric acid, unless we resort to Chilean nitrates, cheap electric power is necessary.

The development of the resources of the South, and sections additional to the one in which such marvelous development has taken place, viz., that along the coast from New England to Virginia, is one of the points high in importance and one we should take note of in our discussions and campaigns for preparedness.

SUGGESTS CENSUS OF THINGS WHICH STAND IN THE WAY OF INDUSTRIAL PREPAREDNESS

ADOLPH L. DE LEEUW. I thoroughly believe in the recommendation of taking a census of all our resources, which may lead to ultimate industrial preparedness. I would like to call attention to the desirability of also making a census of those facts and conditions that may stand in the way of industrial preparedness. One of these facts was mentioned by Professor Williamson.

There is a condition in regard to the manufacture of alcohol which makes it inadvisable for a great many people to take up its manufacture, who otherwise might do so. In case of war, we would not be in a position to manufacture alcohol in the quantities in which we might, if that one obstacle had been removed.

I have been personally able to observe some of the conditions imposed by the Government in making munitions for guns, which probably are entirely satisfactory, if there is no particular hurry and if all that is wanted is just a beautifully made piece of mechanism, but these conditions should not exist if guns are wanted that will shoot tolerably rapid and close and which can be manufactured in a minimum of time. I refer here especially to the matter of limitations. In this case I do not believe the government specifications or limitations are any worse than can be found in almost any industrial establishment, but it has also been our experience that in any shop there are limitations which are entirely too fine; they have simply crept in, and stay until somebody wakes up and discovers them.

As an illustration: A number of years ago, I was in a shop where they made for the Government some twelve-inch mortars of which both the barrel for the outside diameter and the jacket for the bore had allowances of three thousandths. Of course, if the jackets were three thousandths too large and the barrel three thousandths too small, the shrink would have been materially affected. Therefore, there was nothing foolish in this particular case. However, it happened at one time, that one of the barrels was a shade over three thousandths too small and was rejected. This annoyance might have been avoided if dimension with limitation had been given on one of the two pieces and the other piece had contained a notation

giving the difference between bore and outside diameter. In this case it was merely an annoyance to the manufacturer and perhaps a little loss of money, but in case we badly needed a gun, it would have been a different kind of annoyance. This is only a single illustration indicating what might be done in the matter of allowances and limitations. This not only would hold good for guns, but also for ammunition and all other materials to be used.

The census of all those conditions which might be avoided should not merely treat of things that the Government has done which we would like to have changed, but also of things which ordinary private citizens have done. If the Government should ever send out jigs and fixtures to be used in various shops, they would be up against the impossibility of taking a jig or a fixture from one machine and putting it into another, as well as taking it from one shop and placing it into another. Of course, I realize full well that it would not be possible in the course of a few years, to have all planers or shapers and all spindles the same size, but something ought to be done to prevent the annoyance of too much variation, the variation being simply the expression of the desire of some manufacturer to push his product at the expense of his neighbor. If there is any particular reason why his particular size is superior to his neighbor's, well and good, and there is no reason why this size should not be accepted by his neighbor also, but if there is not, the census I have mentioned should take into account the delay and annoyance that might be caused by having too great a variation of designs and sizes in machines. Again, this does not only apply to machines, but to everything. I would, therefore, recommend that in addition to the census of factories, materials, machines, men, executives, etc., there should also be taken a census or list tabulating the conditions which prevent the speedy and easy manufacture of those materials and products which we want.

SAYS INDUSTRIAL CENSUS WILL SHOW WEAKNESS AND BRING ABOUT DESIRABLE CHANGES

MAJOR W. GOFF CAPLES.[1] We should know accurately what we can rely upon in war and should make good, in advance, any deficiencies which the proposed industrial census may show. The nation will need the coöperation of every one, from the manufacturer, the engineer and the chemist, clear through to the laborers in the mills, because wars now are fought not by armies but by nations.

I am glad to see the interest taken in preparedness. My last detail was two years and a half in the organization and equipment of engineer troops. Unless our orders were large, manufacturers were not enthusiastic about our business, because we required special articles. We must have special articles, because a soldier has to carry on his back what he needs for several days, and is limited to 50 pounds, and because we must keep down our wagon transportation to narrow limits, lest the Army be immobilized by too much transportation. An extra ounce or so in the weight of a given article makes little difference in commercial practice, but is of great importance in military practice. Foreign manufacturers were anxious for our business and offered us, frequently, more suitable articles than we could obtain from American manufacturers. We refused all such offers, on the principle that a nation should produce everything it uses in war, and accepted the best that our manufacturers would give us, even though this "best" might not be exactly what we required. The awakened interest of the manufacturers will help greatly, for when the manufacturer and the officer get together in this spirit and understand one another's needs and limitations, both can better serve the nation.

Your census will show what we have and, I hope, bring about such changes that we shall be prepared to supply as large an army as our country can support in war. Your action is a patriotic one and a needed step in the right direction, for it will show us some of our weaknesses and give us a better idea how to remedy our defects.

[1] Queen and Crescent Bldg., New Orleans, La.

THINKS SERVICE OF ENGINEERS SHOULD BE TOWARDS GETTING VALUE FOR MONEY

FRED J. MILLER (written). Engineers have always paid far more attention to efficient organization than have any others, and it seems to me that they might render their best possible service at this time by suggesting such improvements in organization as would result in getting more for the money and effort expended than is at present secured.

From an English statistical authority I take the figures below showing the army budgets of various countries for the year 1913-1914.

Japan	$48,500,000.00
Italy	82,000,000.00
Great Britain	137,000,000.00
U. S. A.	146,000,000.00
France	178,000,000.00
Germany	292,000,000.00
Russia	327,000,000.00

We thus see that only three nations spent more money in the period named than we spent. The figures include the Federal Budget only, with nothing included for the State troops.

Yet we are told by people who should know that our army is a negligible factor and that even for such a job as pursuing a few bandits over the Mexican border its showing is "pitiful."

If that is so and if substantially the same is true of our navy, as we are told that it is, then is it not time for us to try to discover what the $146,000,000 does buy and whether or not some results worth while can be secured by an expenditure of money exceeding that of Great Britain, and exceeded by only the three great military nations, France, Germany and Russia?

Preparation for war is largely an engineering work and the nation which does most in making this work of preparation efficient, that is, in getting the largest possible results for each dollar expended, will have gone a long way in the work of Preparedness and will get the best support from its people upon whom the burden of taxation falls.

SAYS GOVERNMENT NEEDS MANUFACTURING DEPARTMENT WITH CABINET OFFICER AS SECRETARY

ELMER H. NEFF. This paper by Mr. Spencer Miller is extremely interesting and timely. It is, however, as he well indicates, simply an outline of the general subject of "Preparedness." He mentions under the head of "Munitions of War," a wide range of topics, the complete discussion of which would cover the whole range of "preparedness" and fill several volumes. New York City has perhaps been the great storm centre for placing orders for war equipment of every description. When the foreign governments involved in this war began to flood this country with orders, it was simply a question of getting them placed with the utmost expedition. The result has been some confusion with regard to deliveries as herein indicated. The work of taking inventory of shop

facilities for possible use by our own Government can certainly do no harm. It is apparent, however, that the experience gained in filling these foreign orders has placed the shops of the United States in a very good position to take up similar work for our own Government. Our greatest weaknesses are not in the direction of machine shop preparation, but in our facilities for producing the necessary chemical supplies for the manufacture of explosives.

I wish my contribution for this subject to be the suggestion that the United States Government needs a manufacturing department headed by a secretary who should be a Cabinet Officer. I do not in this suggestion have in mind the Government taking up the manufacture of everything it needs. It is already manufacturing on a large scale, and the department which I recommend would take charge of the manufacturing plants which the Government now owns. As you well know, the British Government found after the war had progressed a few months, and things had become hopelessly tangled, that it needed a munitions department. They placed in charge of this department a civilian. Probably you have noticed in the public press that the Navy is very short of officers. If you visit one of our Navy Yards you will find every department in charge of a Naval Officer overseeing in many cases, if not in most cases, construction operations with which he has no training or familiarity. The proper place for the Naval Officers in my opinion is on board ships where we are continually being told there is a shortage of officers. Likewise in every arsenal you will find army officers in charge, men who are not familiar with the work of manufacturing, and have no experience in that direction except what they have picked up while on these temporary details. Colonels, majors, captains, are here a few months, and then on to the next position to which they may be sent. There is no possibility, so far as I can see, that there would be efficient administration under that sort of management. It is no reflection on the army and navy officers that this should be a fact. They are simply the victims of a system of procedure over which they have no control. With a Secretary for Manufacture and civilian experts of the quality that private firms would employ for similar work, placed in charge of the great manufacturing department which the Government owns, a long step towards efficiency, economy, and preparedness would have been taken.

In harmony with the preceding suggestion, I think Mr. Fred J. Miller's discussion of this paper has touched upon a vital point of the whole question. That question relates to the efficiency of the organization of the army and navy, as at present administered,—the question of the returns for the dollars that are being spent. It would seem from the figures quoted by Mr. Miller, that these returns are exceedingly small. If this Society or its committees could investigate and point out methods of improvement, they would have given the country help of the greatest importance.

With regard to the suggestion of a committee to standardize machine tools for munitions manufacture, I do not see the necessity for such a committee. It is a fact that the operations for producing the parts of a military rifle are nearly all performed on standard machine tools. The only thing special about them are the fixtures and tools to go on the machines. For instance, the parts made from bar stock can be made in standard screw machines. The drilling is done in standard grinding machines. The rifle barrels are drilled and rifled in machines which have been standard in this country for years. The punch presses used are standard machines. Similar comments would apply in the main to the production of shells and time fuses. It is therefore, only a question of the best tool equipment for the machines. In this field competition will take care of that, because the buyer, whether for a private plant or for the Government will consider the methods suggested by different manufacturers of machinery, will look into the system of tooling operations proposed, and in that way make the best selection.

Finally I cannot too strongly urge the desirability of the United States Government putting in operation at the earliest possible moment its plants at Springfield and Rock Island, for the production of military rifles. It is an easy matter to obtain men to defend the country, but it is a difficult matter to provide rifles and the ammunition that go with them in the quantities that would be needed in case of war, without great delay.

The experience of all Europe, the successes and failures everywhere, demonstrate that preparedness in its broadest sense means a general spirit of being ready, rather than a particular state of being ready for war.—FRANK B. GILBRETH.

When the supreme test came, Germany was found to be a nation of people who, in general, knew what to do and how to do it; while the industries of England were in too many cases controlled by people who understood only their commercial side.—H. L. GANTT.

What should shock us is not what might happen to us in a war but what is happening right now while there is general peace. National waste, lack of general specific education, lack of easy means for obtaining the fullest education in the vocation for the worker in that vocation, lack of correlation!—FRANK B. GILBRETH.

SAYS MEANING OF INDUSTRIAL PREPAREDNESS IS NOT OFTEN GRASPED. MUST BE UNIVERSAL

J. H. BROPHY[2] contributed a written discussion stating: I am under the impression that it will take years of pounding away at the facts to enlighten people on this great undertaking of Industrial Preparedness.

When using the word "Industrial" it is possible in many instances we fail to grasp its real meaning.

Industrial Preparedness is an extremely vital question, and the meaning of the word Industrial is so deep and reaches so far that it requires a vast amount of labor to impress those in a country of such magnitude as ours what it actually means. To be Industrial in the extreme means a genuine commingling of all lines of business and labor of all descriptions. It might easily be said that this country has at times been awake to the meaning of this word Industrial because we have up to the present time in all sections of the world been considered real leaders in a vast number of enterprises. To improve upon what has happened in the past, when considering the future, means a genuine amalgamation of all with whom we deal. This means that the leading business men should have one thought and that, never to allow the business of this

[2] Cleveland Automatic Machine Co., Cleveland, O.

country to go backwards, always having in mind going ahead, even on a stronger basis than it has ever been before.

The word Preparedness has been used quite extensively of late in this country, and it also has great depth of meaning. I have in mind that the big thing in the way of preparedness in any undertaking means the best use of your thinking powers to plan in advance and follow the path of being ever ready to meet your adversary from a business or your country's standpoint.

Competition from all sections of the world, after this war ceases will be somewhat severe, although a vast number of bright business men are under the impression that we control the world from a manufacturing standpoint. Perhaps we do in a certain sense of the word, but that which is occuring abroad means, from an Industrial standpoint, the men in business should, if possible, have those in their employ thoroughly satisfied, getting men as close as consistent to work along as an organized body. It means a homogeneous mass of brain power, all thinking in one direction, as nearly as possible, constantly having in mind self-protection.

The word Industrial, from the writer's standpoint, cannot be considered of benefit to this great nation if it is not genuinely universal. An educational campaign seems absolutely necessary, and the newspapers are the best channels through which to reach the people of this nation, teaching them to cling and work together, and this must be done with a great pride for our country.

It is a difficult problem and will need a vast amount of time to get those interested in business, as well as the working men, thinking in the same direction, and if they do not, the matter of Industrial Preparedness is liable to be forgotten because it will not reach an actual working condition. To utilize the industrial resources of this country to the very best advantage, there must be a complete unification of all who participate. This can never be accomplished by the aid of a few individuals without the assistance of the Government of this country.

POINTS OUT WEAKNESSES IN SOUTH. SUGGESTS TRADE SCHOOLS FOR WOMEN LIKE AGRICULTURAL SCHOOLS

COMMANDER H. T. WRIGHT[1] said that the discussion of the paper had been mainly upon the question of getting materials and he doubted very much if the visitors from the North realized that in the South it is rather a question of securing men educated in the trades who are able to step into the shops and perform the work necessary to the preparation of war materials.

The South has been very lax in its training of men for trades. In one city in the South, there is a fund of one million dollars for the establishment of a trades school, but although that fund is available, the school has not yet been started. In that city intelligent boys and young men, 18 to 22 years of age, had come to him to work as laborers. They told him that they had attempted to learn a trade, but there was no such thing in that city as an apprenticeship system. There is nothing in the South that parallels such splendid apprenticeship systems of the North as those of the Westinghouse Companies, the Western Electric Company and the Fore River Shipbuilding and Engine Company. The South cannot mobilize an army of workmen unless it first educates them.

It will take a long time to build up that force of working men who must be the backbone of any industrial preparedness no matter how many raw materials are available or how many machine shops are lying idle. Industrial preparedness cannot be obtained without the men to manufacture the raw materials and to operate the shops.

In time of war many of the best *men* have to go to the front, with the result that women must be employed in the industrial trades. Very few in the South know about the women of the North who are willing to be employees in the manufacture of war material, textiles, etc. The South has been and always will be slow to approve and start the mobilization of the women of America in the industrial trades. But why not at least have, as an addition to the agricultural schools, trades schools for girls, to give them a fundamental knowledge of the trades in order that they will be ready?

Another thing in which the South is very weak is functionalization, but it is hoped that this will be accomplished in the trades schools that are going to be established in the country.

Bearing on the question of the education of the mechanic and touching closely the question of the mobilization of the American women in industrial preparedness is the question of coöperation. The following quotation from Frederick W. Taylor, Past President of The American Society of Mechanical Engineers and the highest exponent of coöperation, gives perhaps the briefest and the most concise statement of coöperation: "The time has come when all great things will be accomplished by the coöperation of many individuals, each performing the function for which he is best suited, each supreme in his particular function, yet retaining his individuality, while collaborating with his fellows toward the production of the complete and perfect whole."

Commander Wright spoke briefly in regard to materials and said that while it is true that the Government specifications must not be too severe and that they must be reasonable, it is also necessary to get as much as possible out of the material. The question of tolerances had been brought up and a speaker said that all that was needed was the proper correlation of parts. Commander Wright said that he did not know whether the speaker realized that the Navy retubes every one of its big guns and that each is retubed when it is taken off a ship after it has been fired 200 or 300 times. When the materials are to be used over and over again, merely replacing defective parts, mechanical tolerances have to be watched closely.

It would require 50 engineers, designers and draftsmen at least 50 weeks to prepare the drawings for the 17 sizes of shells now used by the U. S. Army, together with drawings for gages, jigs, fixtures and tools. To produce the latter would probably require 800 men, well trained and in well organized factories, at least 5 years. This would equip 100 factories, each employing 2,000 men, capable of producing a total of 200,000 rounds per day.—FRANK O. WELLS and CHAS. E. SMART.

It would take 1,000 toolmakers one year to furnish tools . . . for an output of 1,000 rifles per day. Therefore should our Government require, say, 5,000,000 rifles, or 1,000,000 rifles per year, our tool plants would be taxed to the utmost.—K. A. JUTHE.

[1] U. S. Naval Station, New Orleans, La.

CURRENT TOPICS

The Engineer, April 28, 1916, describes a new type of Humphrey pump working on a two-stroke cycle, the novelty of the construction being that a solid mass is placed, as it were, between the exploding gaseous mixture and the water surface. All the useful work is done on the up-stroke during the expansion of the gases. On the down stroke, the work is spent against friction and in compressing the fresh charge. A feature of the design lies in the fact that no side-thrust is generated at any point by the piston against the cylinder walls as in an ordinary crank pump. The movement is purely reciprocating and there is an entire absence of rotating parts except for the exhaust valve bell-crank lever.

One of the most notable achievements in gas engineering is the successful construction of a subaqueous tunnel connecting Astoria, L. I., with the borough of The Bronx, New York City. The tunnel lies beneath the waters of the East River at an average depth of 225 ft. below mean sea level. It is 19 ft. wide, 18 ft. high and 4662 ft. long. It accommodates two 72-in. gas mains, with abundant space for other utilities. The route of the tunnel lays through a long stretch of disintegrated rock where the water pressures ran up to 95 lb. per sq. in., thus making it impossible to use compressed air to exclude water.

Three principal (anhydrous) oxides of iron have long been familiar in chemical literature: ferric oxide, Fe_2O_3, occurring in nature as the mineral *hematite;* ferroso-ferric oxide, Fe_3O_4, occurring as *magnetite;* and ferrous oxide, FeO, which is not known to occur in nature. A less common mineral form is *martite,* which has a somewhat variable composition immediately between Fe_2O_3 and Fe_3O_4. It is commonly described as "hematite pseudomorph after magnetite," as it usually lies nearer hematite than magnetite in composition, but has the external octahedral form of magnetite. In addition to these natural oxides, many other oxides have been prepared and described by various investigators.—*The Oxides of Iron, Jour. Am. Chem. Soc., April, 1916.*

Sheet steel or iron containing copper shows greatly increased corrosion resistance when exposed to atmospheric conditions. The most effective amount of copper to be used for this purpose is approximately 0.25 per cent. Smaller amounts of copper down to as little as 0.04 per cent have a considerable influence in lessening corrosion.

Phosphorus added to open-hearth steel slightly lowers the corrosion rate. Silicon, while probably without effect in the amounts normally present in open-hearth and bessemer steel, accelerates corrosion when added in amounts from 0.10 to 0.30 per cent. The addition of small amounts of aluminum probably has little influence on corrosion. The addition of sulphur to steel greatly increases the corrosion rate. The addition of cold steel to molten steel does not lower the corrosion rate, but if it has any influence at all, it is to increase the corrosion.—*Jour. Ind. & Eng. Chem., Vol. 8, No. 3.*

The Hudson Motor Car Company has recently carried out some interesting experiments on the determination of the rigidity of crankshafts, for which an ingenious rig was used. The shaft was supported vertically so as to eliminate the possibility of bend due to overhang. In order to eliminate any chance of torsional strain due to an auxiliary driving mechanism, the fly-wheel with its face provided with teeth was converted into a turbine, several air nozzles being arranged to revolve it without actual mechanical connection.—*The Automobile,* May 18, 1916.

An interesting paper on theory and practice in the filtration of water was presented before the Institution of Mechanical Engineers on April 14, 1916. The author establishes the following conclusions: (1) the practice of mechanical filtration is based on the theory that the filtering film is essential; (2) the speed of the filters is always high so that the length of time during which the water is under treatment is not considered of importance; (3) when cleaning, the filter materials are violently agitated throughout their mass; and (4) the bacteriological purification of water is dependent on a single operation carried out with extreme rapidity, and the sole means for preventing the passage of pathogenic organisms through the filter consists of an artificial gelatinous film.

The chemistry of water softening is fairly complete, but there are still a number of undetermined points about which more information is desirable. Such, for instance, are the questions of foaming and of after-deposits.

The foaming in a steam boiler is more active if the water contains comparatively large amounts of soluble salts or organic matter. It will increase as the concentration of the water increases.—S. A. Greeley, in *Jour. Am. Water Works Assn., Vol. 3, No. 1.*

The subject of power plant losses at high altitudes is discussed by A. Vincent Clarke in the *Compressed Air Magazine* for May, 1916. Oil engines working at high altitudes cannot develop the same power as at sea level owing to the smaller weight of oxygen contained in the cylinder. At an elevation of 10,000 cu. ft., the pressure of the atmosphere is about 10.3 lb. per sq. in.; hence at the commencement of compression the engine cylinder will be full of air at a pressure of 10.3 lb., whereas at sea level the same volume of air would be present at a pressure of 14.7 lb. As the amount of oxygen would be in the same proportion in both cases, the power obtainable would be in the ratio of 14.7 to 10.3, giving a loss of about 29 per cent because of the high altitude.

With internal combustion engines when the initial pressure is reduced the compression pressure will be lower.

Diesel engines at high altitudes require a larger compressor for the air used for the injection of fuel than is necessary at sea level, as it is essential for their satisfactory operation to have the same volume and pressure of air as at sea level.

REPORT UPON EFFICIENCY TESTS OF A 30,000 KW. CROSS-COMPOUND STEAM TURBINE

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Member of the Society Non-Member

THE determining factors in the selection of power generating equipment, either for an original installation or replacement purposes, present about as many variables as there are installations. Engineering experience has practically standardized the electrical end. The steam engine on the other hand, does not seem to have been capable of such standardization, as engineers are not agreed as to the most desirable superheat, pressure, etc., which must be considered both from the standpoint of reliability and boiler and engine economy. This thought is more than ever pertinent at this time, as it appears that we are on the eve of the employment of higher pressures and perhaps even new systems of power generation.

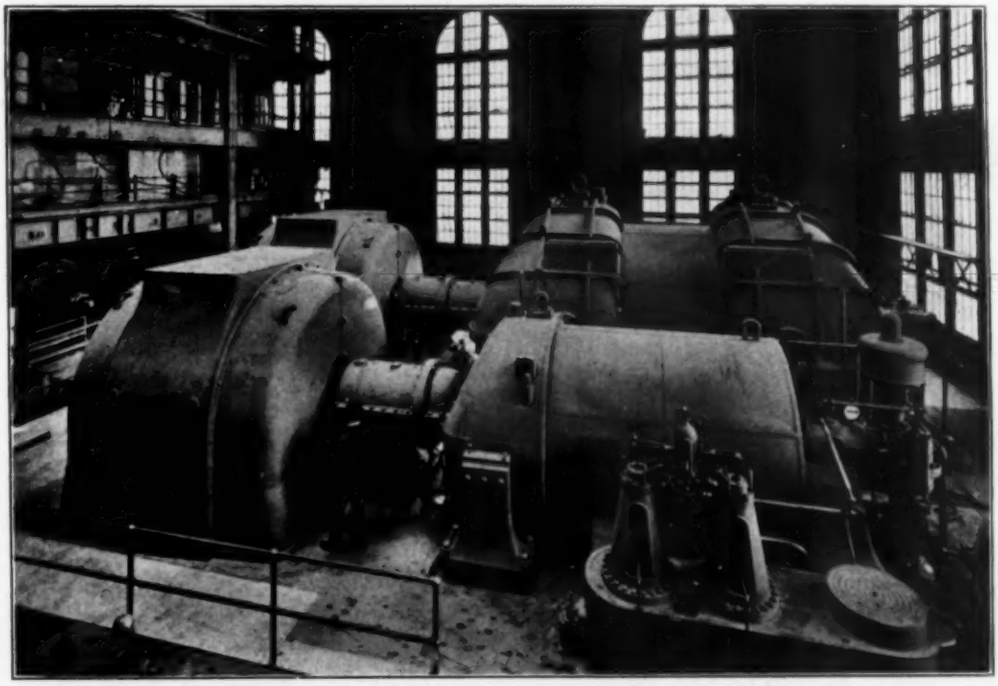


FIG. 1 30,000 KW. CROSS-COMPOUND STEAM TURBINE

Further, the capacity of the machine to be selected and the relation of point of best steam consumption to maximum continuous load and provision for heavy overloads for limited periods are all dependent on load factors, diversity factors, etc., which present a new problem for every installation.

Without detailing at length the considerations which led to the selection of three 30,000 kw. units for the 74th Street Station of the Interborough Rapid Transit Company, a brief summation of the main questions involved will possibly be of interest and serve to classify the installation properly.

The prospective daily plant load, as was subsequently demonstrated, could be best provided for by units of 30,000 kw. maximum continuous capacity each. At that time there was assurance that machines of this capacity could be constructed and furthermore, by the employment of the two-speed compound principle, as described more fully hereinafter, no hazards were involved, nor in fact would there be any departure from well tried principles of construction. Ample steam supply was available by reason of development in the matter of relative boiler capacity coincident with the increase in efficiency of prime movers since the original construction of the plant in 1902. Economic considerations warranted the withdrawal of the horizontal-vertical double cross-compound engine-generator sets installed at that time, and their replacement by more efficient and larger units.

The generally accepted essential requirements of a railroad plant were the next considerations, viz.: reliability, efficiency and cost.

In the development of turbine design, at the time the installation was being considered, possibly the simplest type of machine in many ways was the single-shaft, single-rotating element turbine as a natural outgrowth of the generally accepted type developed in smaller capacities. Certain structural features, however, inherent with the larger capacity tended to favor the division of the unit into two elements.

In a steam turbine, maximum centrifugal stresses are encountered at the exhaust end, where the greatest steam

Presented at the May, 1916, meeting of the New York local section of The American Society of Mechanical Engineers.

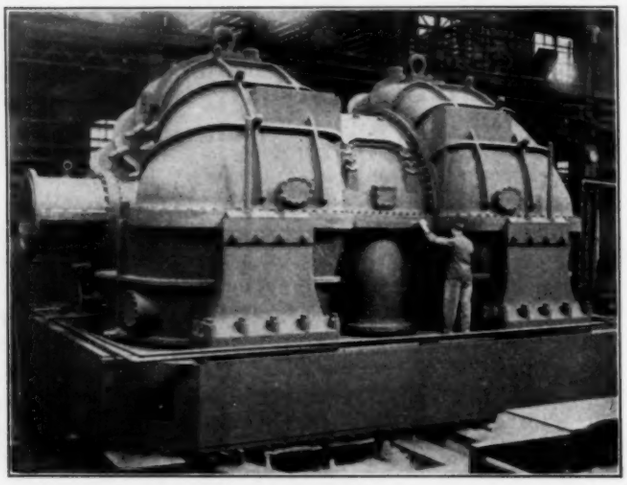


FIG. 2 CASING, LOW-PRESSURE TURBINE

volume requires the greatest blade area. In the high-pressure blading which uses steam of small specific volume, the best velocity ratio conducive to high economy cannot be met by the rotative speed as determined by the exhaust end. To avoid a compromise, the conditions are more readily satisfied by carrying out the expansion in two separate elements, and avoiding congestion due to the high specific volume of the steam at one inch absolute exhaust pressure by the use of the lower speed, longer blades and the double-flow principle.

Reliability also seemed better served in the double element machine by the shorter shaft, and reduction of danger from temperature strains. Furthermore, there was the possibility, in an emergency, of operating either element of the unit alone, and that at a fairly high efficiency, the low-pressure element being available for service simply by the use of a by-pass. The use of the high-pressure end alone in the case of a bad breakdown on the low-pressure end was to be obtained by removing the low-pressure rotor and closing the shaft openings with special covers.

An extremely important consideration, favoring the divided unit in this particular case, was the matter of the weight of the parts to be handled by the crane which, in the case of the single unit, involved provision for additional crane capacity beyond that then available at the plant. To take care of such additional requirements would have necessitated the installation not only of a new crane, but reinforcements of the steel work of a most elaborate nature and far in excess of that required for use in connection with the double unit.

In the matter of efficiency the double unit offered still more desirable possibilities, prominent among which was the relative flatness of its water rate characteristic. Without entering into the matter of cost in this particular case, it may be said that the advantage was again with the double unit.

As a result of such considerations as the foregoing, the double-unit turbines were selected, together with condensing equipment designed to perform at a relatively high rate of efficiency, and including the necessary auxiliary apparatus, all of which is described in the following:

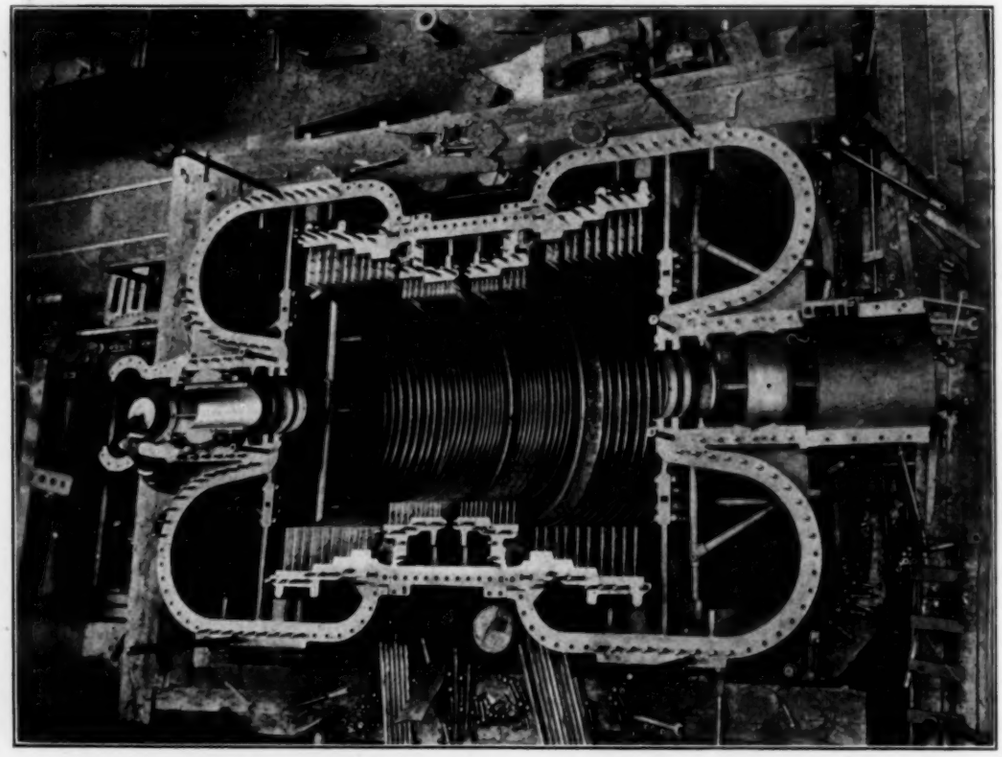


FIG. 3 INTERIOR, LOWER HALF OF LOW-PRESSURE TURBINE

One of the complete units is shown in Fig. 1, the high-pressure element with its governing apparatus being in the foreground. This element is practically a typical single-cylinder reaction turbine, containing 38 rows of blades. The low-pressure element in the background of Fig. 1 is a turbine of the double-flow type. The casing is possibly unusual in its size and details of reinforcement. The complete casing of a low-pressure element is shown in Fig. 2, and the interior of

the lower half in Fig. 3. Fig. 4 shows a detail of the lower casing with the rings removed which gives a very clear idea of the reinforcing. No blading is mounted directly in the casing but through the intermediary of rings secured to it, as shown in Figs. 3 and 10. The central portion of the low-pressure rotor (Fig. 5) consists of a drum to which are bolted two cast steel shaft ends. These shaft ends have discs mounted upon them, carrying the last rows of blades.

Each turbine was erected upon a foundation of steel framework set in concrete, the steel structure alone being amply sufficient for support, the concrete being added to eliminate vibration.

Inasmuch as the high-pressure rotor was inherently of small diameter, it was possible to design it to operate at the maximum speed possible for 25 cycle service, i. e., 1500 r.p.m. The low-pressure turbine was designed for the next lower synchronous speed, namely, 750 r.p.m., utilizing a four-pole generator.

The surface condensers which occupy most of the open space beneath the foundation framework consist each of two shells containing 25,000 sq. ft. of condensing surface apiece. The condenser shells are connected directly to the turbine outlets without an intermediate expansion joint. The weight of the condensers is carried by means of lugs, cast as a part of the shell, resting upon a number of spring jacks, which are adjusted to carry the load without appreciable strain upon the turbine exhaust nozzles. Practically no restraint has been put upon longitudinal expansion of the low-pressure turbine by the circulating water piping, which is fitted with rubber expansion joints. There is one expansion joint of copper in the steam equalizing pipe between the shells.

The condenser auxiliaries were selected and installed with the prime factor of reliability continually in mind. The turbine-driven tri-rotor circulating pumps of 37,500 gal. per min. capacity each were installed in duplicate, the reliability consideration being augmented by one of efficiency in the matter of the relative requirements for winter and summer use; during the winter months with cold water one pump is sufficient, but during the summer months high water temperatures necessitating two units in service.

The hot well pumps were also installed in duplicate. A single rotary dry vacuum pump was provided for each unit, with sufficient capacity to handle the dry air from two units, cross connections being provided for the purpose.

The turbines are equipped with water-sealed glands. The gland water system has a small centrifugal turbine-driven

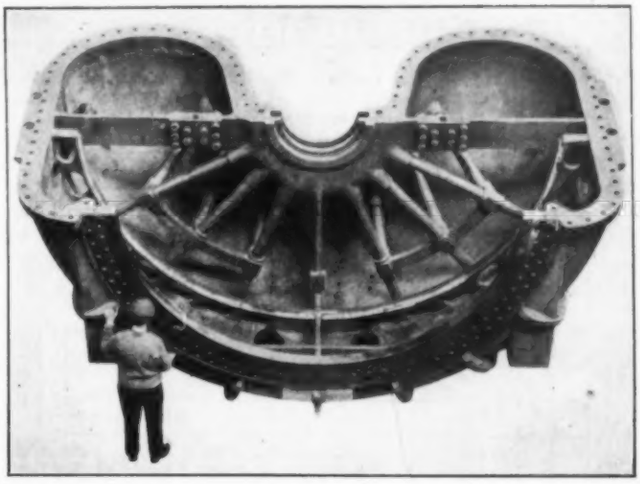


FIG. 4 DETAIL SHOWING BRACING, LOW-PRESSURE CASING

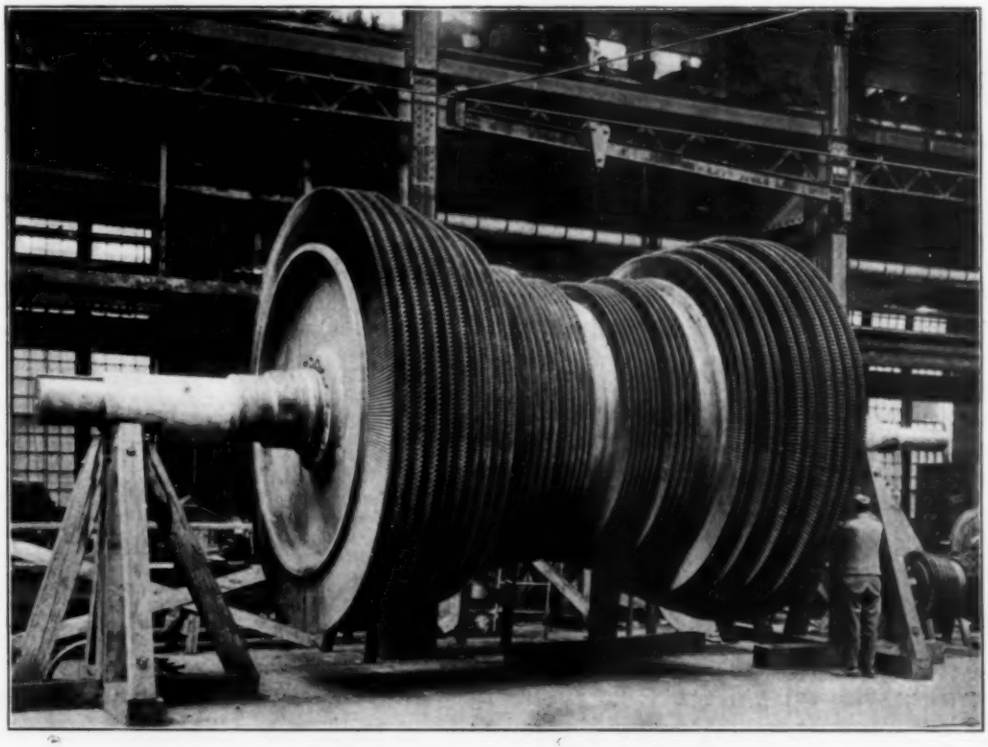


FIG. 5 ROTOR, LOW-PRESSURE TURBINE

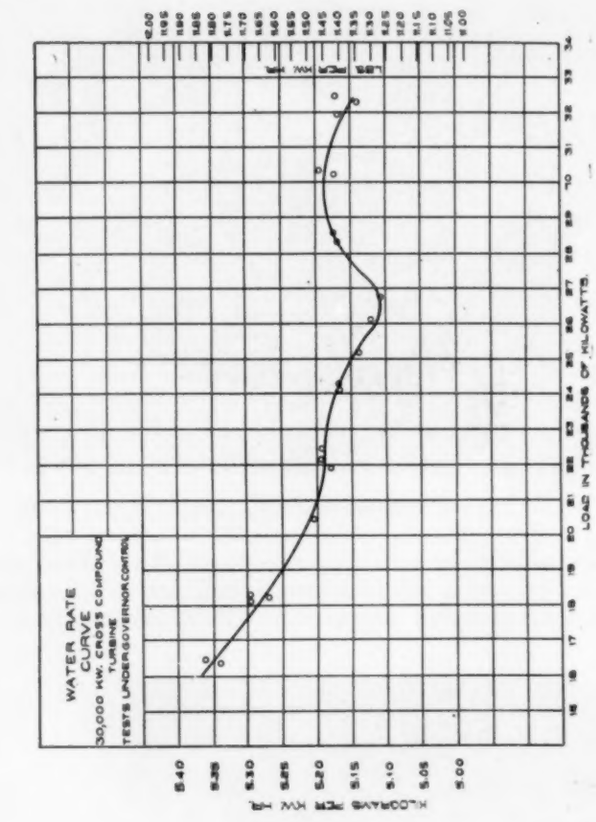

WATER RATE CURVE
30,000 KW. CROSS COMPOUND TURBINE
TESTS UNDER GOVERNOR CONTROL
LOAD IN THOUSANDS OF KILOWATTS
KILOGRAMS PER KW HR.
LBS. PER KW HR.

FIG. 7

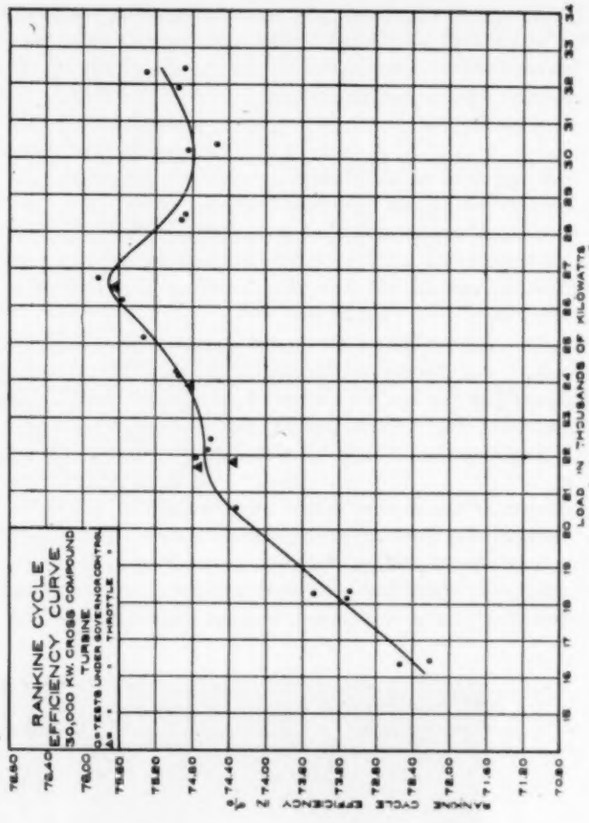

RANKINE CYCLE EFFICIENCY CURVE
30,000 KW. CROSS COMPOUND TURBINE
TESTS UNDER GOVERNOR CONTROL
THROTTLE
LOAD IN THOUSANDS OF KILOWATTS
RANKINE CYCLE EFFICIENCY IN %

FIG. 9

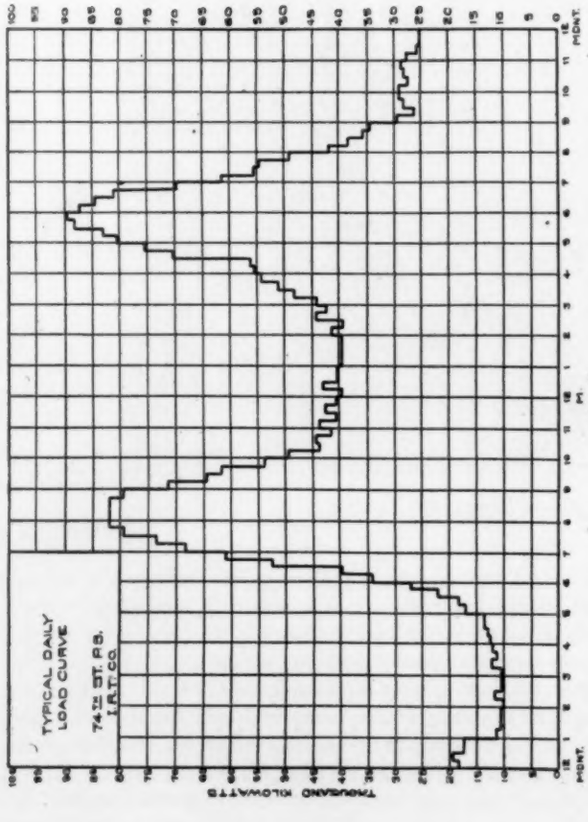


FIG. 6

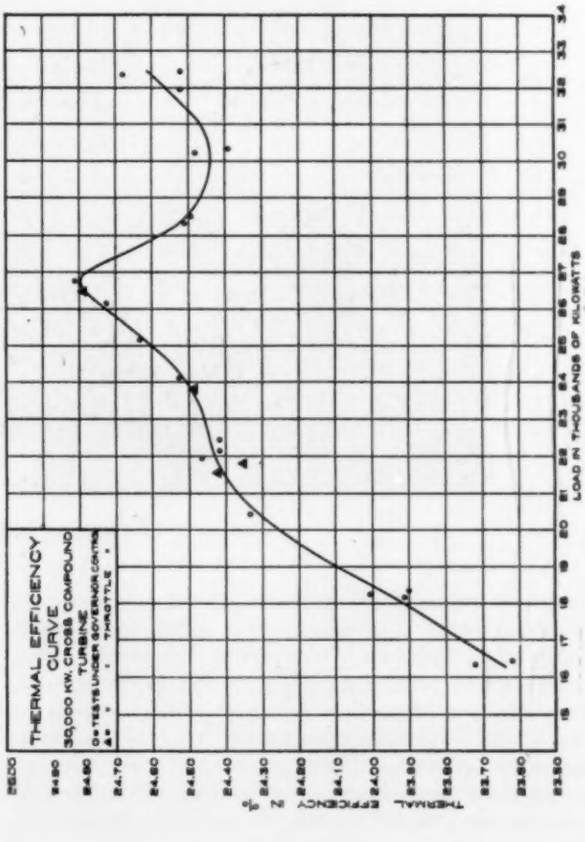


FIG. 8

PERFORMANCE CURVES, 30,000 KW. STEAM TURBINE

TABLE 1 SWINGING LOADS DURING TESTS AS RECORDED BY GRAPHIC CHART

Test No.	Duration of Test, Hr.	Average	From Graphic Load Chart									
		Kw. Load by Watthour Meter *A*	Minimum Load During Test *B*	Maximum Load During Test *C*	Difference in Kw. of Max. and Min. Loads *C—B = D*	Per Cent of Avg. Load *D / A*	Avg. of Diff. Bet. Min. and Max. Load During Each 2½ Min. Period During Test *E*	Per Cent of Avg. Load *E / A*	Max. Single Load Swing During Test *F*	Per Cent of Avg. Load *F / A*	Length of Swing *F* in Sec.	Time of Test
1	3	16342	10100	20800	10700	65.5	6080	37.2	8700	53.3	21	12.00– 3.00
2	3	16447	9800	20300	10500	63.8	6200	37.7	8200	49.8	40	12.00– 3.00
3	3	18158	12800	23000	10200	56.2	5680	31.3	7800	43.0	34	1.00– 4.00
4	3	18273	10400	23100	12700	69.5	5860	58.6	10600	58.0	41	12.00– 3.00
5	3	18317	11600	22000	10400	56.8	6360	34.7	9400	51.3	24	12.00– 3.00
6	3	20472	15600	22600	7000	34.2	3810	18.6	6500	31.8	42	2.00– 5.00
7	3	21925	14900	26100	11200	51.1	3740	17.1	6650	30.3	26	8.00–11.00
8	3	22150	16500	27400	10900	49.2	4200	19.0	6500	29.4	24	8.00–11.00
9	3	22432	16900	25400	8500	37.9	4580	20.4	7400	33.0	33	8.00–11.00
10	3	24137	18700	27800	9100	37.7	3700	15.3	6900	28.6	36	8.00–11.00
11	3	24200	20500	27600	7100	29.3	3160	13.1	4300	17.8	15	8.00–11.00
12	3	25170	19700	27400	7700	30.6	3260	13.0	5500	21.9	12	10.30– 1.30
13	3	26153	20200	28900	8700	33.3	3080	11.8	5400	20.6	12	8.00–11.00
15	3	28378	21000	32700	11700	41.2	3700	13.0	5400	19.0	1	3.30– 6.30
16	3	28517	23200	29700	6500	22.8	2200	7.7	4000	14.0	11	3.30– 6.30
17	3	30232	24400	32000	7600	25.1	3040	10.1	4500	14.9	12	3.30– 6.30
18	3	30397	24600	32800	8200	27.0	2780	9.1	5600	18.4	2	3.30– 6.30
19	3	31986	29400	35200	5800	18.1	2450	7.7	3700	11.6	9	4.00– 7.00
20	3	32348	32900	28300	4600	14.2	2490	7.7	3100	9.6	5	4.00– 7.00

Test 19–22 incl.—no chart taken.

TABLE 2 SUMMARY OF RESULTS, TURBINE TESTS

Test No.	Abs. Steam Pressure at Throttle		Steam Temperature at Throttle		Superheat		Abs. Steam Pressure Primary Inlet		Abs. Steam Pressure Exhaust H.P.		Abs. Steam Pressure Inlet L.P.		Exhaust Vacuum		Exh. Pres. Referred to 30-In. Bar, 762 M M. 58.1 Deg. Fahr., 14.5 Deg. Cent.		Load Average	Water per Hr.		Water[1] Rate		Rankine[1] Cycle Efficiency	Thermal[1] Efficiency
	Lb. per Sq. In.	Kg. per Sq. Cm.	Deg. Fahr.	Deg. Cent.	Deg. Fahr.	Deg. Cent.	Lb. per Sq. In.	Kg. per Sq. Cm.	Lb. per Sq. In.	Kg. per Sq. Cm.	Lb. per Sq. In.	Kg. per Sq. Cm.	In. Hg.	MM. Hg.	In. Hg.	MM. Hg.	Kw.	Lb.	Kg	Lb. per Kw.-Hr.	Kg. per Kw.-Hr.	Per Cent.	Per Cent.
1	224.3	15.78	493.2	256.2	101.6	56.5	148	10.41	10.6	.745	10.2	.717	28.411	721.63	1.589	40.37	16,342	192,350	87,250	11.770	5.339	72.540	23.72
2	223.3	15.7	486.8	252.7	95.8	53.2	144	10.12	11.8	.83	10.0	.703	28.52	724.41	1.48	37.59	16,447	194,431	88,194	11.822	5.362	72.222	23.62
3	224.1	15.77	485.7	252.1	94.2	52.3	166	11.68	...	...	11.0	.773	28.539	724.9	1.461	37.1	18,158	212,029	96,176	11.677	5.297	73.118	23.91
4	223.3	15.7	489.6	254.2	98.4	54.7	159	11.18	11.8	.83	11.5	.809	28.471	723.15	1.529	38.85	18,273	212,330	96,313	11.620	5.271	73.476	24.02
5	222.6	15.65	496.5	258.05	105.7	58.7	163	11.46	11.8	.83	10.8	.759	28.588	726.15	1.412	35.85	18,317	213,976	97,059	11.682	5.299	73.086	23.90
6	220.4	15.5	510.9	266.1	121.0	67.3	175	12.31	12.7	.893	12.0	.844	28.586	726.08	1.414	35.92	20,472	234,930	106,564	11.476	5.206	74.400	24.33
7	219.8	15.46	519.3	270.7	129.5	72.0	182	12.8	12.8	.9	12.5	.879	28.683	728.55	1.317	33.45	21,925	250,407	113,585	11.421	5.181	74.757	24.46
8	221.8	15.6	518.8	270.5	128.0	71.1	185	13.01	13.5	.949	12.8	.9	28.791	731.3	1.209	30.7	22,150	253,388	114,937	11.439	5.189	74.630	24.41
9	221.1	15.54	501.5	260.8	111.2	61.8	187	13.15	...	...	13.0	.914	28.744	730.1	1.256	31.9	22,432	256,716	116,446	11.444	5.191	74.606	24.41
10	221.3	15.56	513.9	267.7	123.5	68.6	194	13.64	14.2	.998	14.1	.992	28.902	734.1	1.098	27.9	24,137	274,971	124,727	11.392	5.167	74.947	24.52
11	220.3	15.49	512.9	267.2	123.0	68.4	196	13.78	13.7	.963	13.6	.956	28.882	733.6	1.118	28.4	24,200	275,593	125,009	11.388	5.166	74.973	24.52
12	220.3	15.49	496.8	258.2	106.8	59.4	197	13.85	14.6	1.027	14.1	.992	28.896	734.0	1.104	28.0	25,170	285,184	129,359	11.330	5.139	75.357	24.63
13	217.9	15.32	524.3	273.5	135.2	75.2	211	14.84	14.5	1.019	14.7	1.033	28.761	730.53	1.239	31.47	26,153	295,373	133,981	11.294	5.123	75.597	24.72
14	224.0	15.76	500.0	260.	108.5	60.3	215	15.12	...	...	15.0	1.055	28.862	733.1	1.138	28.9	26,740	301,035	136,549	11.258	5.107	75.840	24.81
15	221.6	15.58	510.0	265.5	119.5	66.4	210	14.77	16.5	1.16	15.9	1.118	28.862	733.1	1.138	28.9	28,378	323,353	146,673	11.395	5.169	74.928	24.51
16	220.0	15.47	515.5	268.6	125.6	69.8	211	14.84	16.6	1.167	16.2	1.138	28.812	731.82	1.188	31.18	28,517	325,072	147,453	11.399	5.171	74.901	24.49
17	220.3	15.49	513.0	267.2	123.0	68.4	210	14.77	16.5	1.16	16.8	1.181	28.78	731.01	1.22	30.99	30,232	344,787	156,395	11.405	5.173	74.862	24.48
18	217.2	15.28	518.0	270.0	129.1	71.8	206	14.48	17.3	1.216	17.2	1.208	28.801	731.55	1.199	30.40	30,397	348,018	157,861	11.449	5.193	74.574	24.39
19	217.1	15.27	515.4	268.6	126.6	70.3	212	14.9	18.5	1.301	18.5	1.301	28.623	727.03	1.377	34.97	31,986	364,280	165,237	11.389	5.166	74.968	24.52
20	218.2	15.33	519.5	270.8	130.4	72.5	209	14.7	17.6	1.237	18.2	1.28	28.75	730.25	1.25	31.75	32,348	366,572	166,277	11.332	5.140	75.343	24.64
21	216.3	15.21	513.3	267.4	124.9	69.4	209	14.7	18.1	1.272	18.9	1.328	28.765	730.63	1.235	31.37	32,490	370,335	167,984	11.398	5.1701	74.908	24.52
22	222.8	15.66	518.0	270.2	127.0	70.5	182	12.78	13.9	.976	13.0	.913	28.55	724.70	1.45	36.83	21,610	246,661	111,850	11.414	5.179	74.733	24.42
23	224.0	15.76	508.0	264.5	116.5	64.5	186	13.05	14.2	.998	13.3	.934	28.53	724.67	1.47	37.23	21,800	250,134	113,600	11.474	5.207	74.412	24.35
24	222.9	15.67	512.0	266.7	121.0	67.3	194	13.66	14.8	1.042	13.9	.976	28.92	734.57	1.08	27.43	23,890	272,335	123,600	11.400	5.170	74.824	24.48
25	223.1	15.67	515.4	268.9	124.3	69.0	213	14.98	16.2	1.139	15.1	1.062	28.85	732.8	1.15	33.15	26,505	298,810	135,600	11.274	5.114	75.660	24.79

[1] as corrected to 215 lb. per sq. in. or 15.1 Kg. per sq. cm. Abs. Press.; 120 deg. fahr. (66.6 deg. cent.), super heat; 29 in. Hg. (736.6 mm.)

pump for each unit, the piping for all of which is cross connected through a common header. The water used for the turbine oil coolers returns the heat which is thus regained by way of the feed water heaters.

The exhaust from the auxiliaries has been carried into the feed water heaters which operate at low pressure. The shortage or excess of heat in this heater system, as the case may be, is compensated for or utilized by means of heat balance valves operating between the auxiliary exhaust lines and the receivers between the turbine elements.

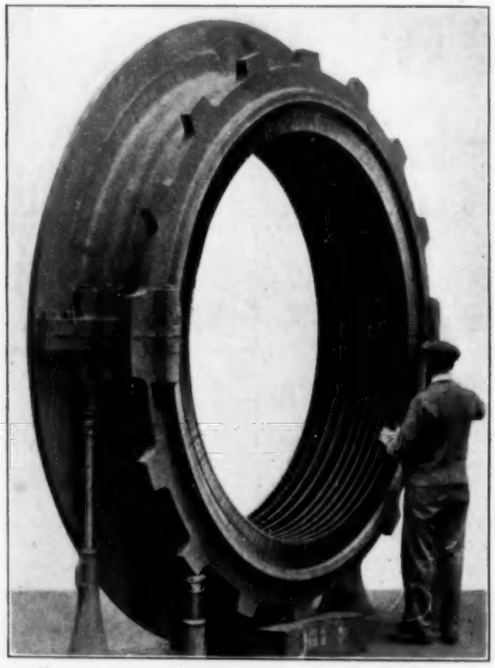


FIG. 10 RING SECTION OF LOW-PRESSURE BLADES

For test purposes one unit was selected as representative of the installation. Tests were made upon this unit by the use of standard methods, special provisions being taken to secure accuracy, some of which are detailed below:

High steam pressures were observed by the use of gages, in duplicate where of importance, such gages being calibrated before and after each test. Temperatures were observed by carefully calibrated thermometers, immersed in iron pipe wells, filled with mercury or oil, depending upon conditions. Wells were of ample depth and correction was made for immersion. Low pressures were observed by the use of mercury manometers. Vacuum readings were made by the use of mercury columns provided with a vernier reading to 1/100 of an inch. The mercury in these columns was regularly cleaned and its specific gravity determined before and after test series and corrections made accordingly. Temperature corrections on mercury columns were provided for by the use of thermometers set in each column casing and additional corrections were made for specific gravity, meniscus and barometer reading. The barometer used on the test was calibrated by reference to the U. S. Weather Bureau.

The condensate was weighed in tanks mounted upon two carefully calibrated platform scales. Platform scales were also used to measure drips and leakage. The unit was isolated so far as water and steam outlets were concerned. The large atmospheric relief valve necessarily remaining connected to the exhaust system was water sealed, the seal being kept under continual observation by means of a window in the valve cover and interior illumination by electric light.

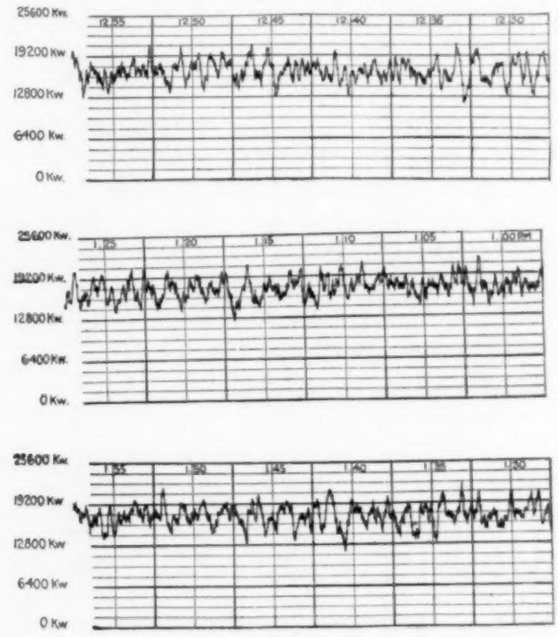


FIG. 11 WATTHOUR METER CHARTS

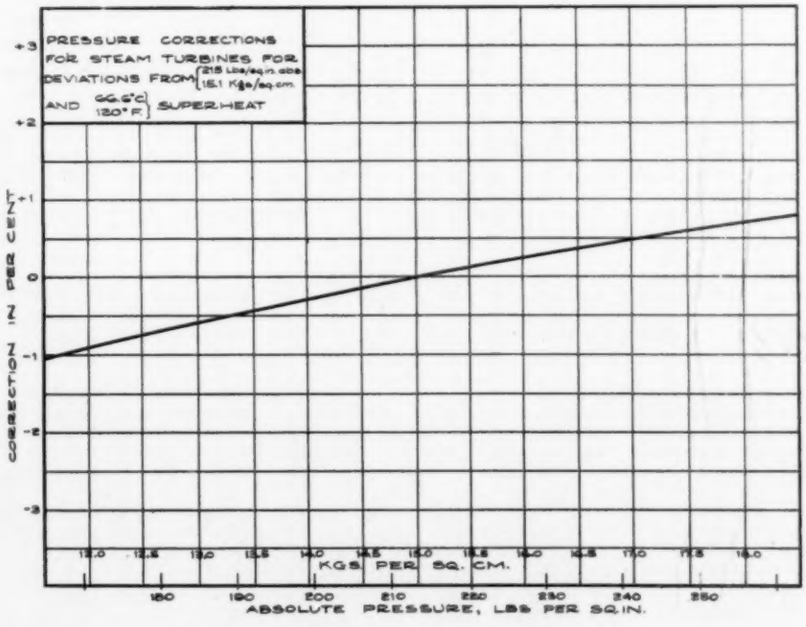


FIG. 12 PRESSURE CORRECTION CHART

The unit output was obtained by means of three single

phase rotating standard watthour meters, one connected to each phase. These watthour meters were calibrated before and after the test series, which calibration included the current and potential transformers and showed no variation in excess of 0.2 per cent.

Each test was of three hours' duration with about a half hour preliminary operation under test conditions. The load was controlled from the switchboard, the turbine operating upon the governor with hand throttle wide open. This subjected the turbine to the full swings of the railroad load, as observed by means of a graphic wattmeter, which furnished an interesting index of such load variations. Table 1 gives a summary of the results of these charts and Fig. 11 shows a typical section of a chart. At light loads these variations were more pronounced, approximating frequently 5000 kw. either side of the average. A variation of 10,000 kw. total in half a minute was not uncommon, especially on loads of 16,000, 18,000 and 20,000 kilowatts.

The test results have been shown graphically in Figs. 7, 8 and 9, upon bases of load and water-rate, load and thermal efficiency, and load and Rankine cycle efficiency ratio. In conducting these tests, naturally every effort was made to maintain certain standard conditions under which guarantees had been given, and the test results as tabulated have been corrected to such standards. These standards represent what is probably the average of operating service. Corrections for variation from standard conditions were based upon curves as shown in Figs. 12, 13 and 14, which corrections were agreed upon prior to the commencement of tests.

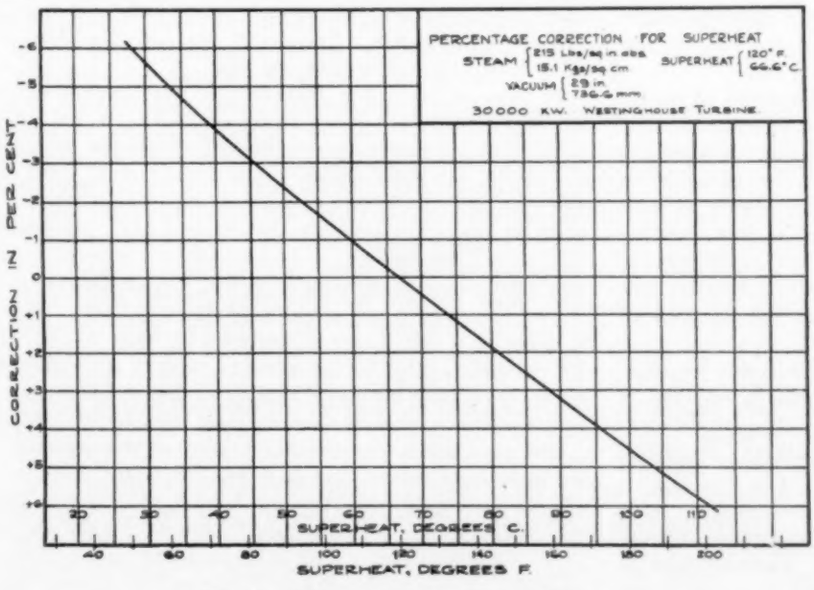

PERCENTAGE CORRECTION FOR SUPERHEAT
STEAM 215 Lbs/sq in abs 15.1 Kgs/sq cm
SUPERHEAT 120° F. 66.6° C
VACUUM 29 in. 736.6 mm.
30000 KW. WESTINGHOUSE TURBINE
CORRECTION IN PER CENT
SUPERHEAT, DEGREES C.
SUPERHEAT, DEGREES F.

FIG. 13 SUPERHEAT CORRECTION CHART

In discussing and analyzing the test results, attention might be called to the following particular features:

1. With due allowance for scale of ordinates the performance curves may be considered unusually flat, naturally conducive to high plant efficiency.

2. The dip in the curve between 22,000 kw. and 26,000 kw. is a peculiarity which was received at first rather skeptically, but which was later remarkably checked by repetition of tests throughout the range, including a special series under steady load made three months subsequent to the original series and given herein as Nos. 22-26 in the tables showing test summaries. Various theories have been advanced in connection with this dip and a series of special tests was made to investigate the relative action of the receiver between the two cylinders as a separator, and the velocities of the steam passing through it, with the idea that this might have some direct bearing upon this dip. Unfortunately, winter load demands terminated further research work in this direction without any definite results having been obtained.

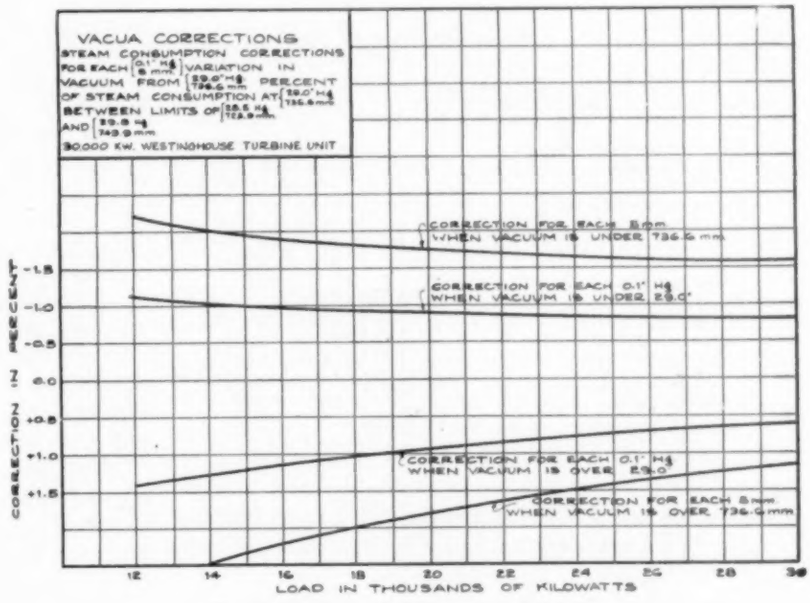

VACUA CORRECTIONS
STEAM CONSUMPTION CORRECTIONS FOR EACH 0.1" Hg 2.5 mm VARIATION IN VACUUM FROM 29.0" Hg 736.6 mm OF STEAM CONSUMPTION AT 29.0" Hg 736.6 mm BETWEEN LIMITS OF 28.5 Hg 723.9 mm AND 29.8 Hg 743.0 mm
30000 KW. WESTINGHOUSE TURBINE UNIT
CORRECTION FOR EACH 2mm WHEN VACUUM IS UNDER 736.6 mm
CORRECTION FOR EACH 0.1" Hg WHEN VACUUM IS UNDER 29.0"
CORRECTION FOR EACH 0.1" Hg WHEN VACUUM IS OVER 29.0
CORRECTION FOR EACH 2mm WHEN VACUUM IS OVER 736.6 mm
CORRECTION IN PER CENT
LOAD IN THOUSANDS OF KILOWATTS

FIG. 14 VACUA CORRECTION CHART

3. The turning up of the curve between 30,000 and 32,000 kw. is another peculiarity, accounted for by the turbine designer as follows:

"Concerning the supposed inconsistency in these tests, i.e., the turning up of the efficiency curve between 30,000 and 32,000 kw., consideration and figuring indicate that this is actually not an inconsistency, but a new experience. This turbine was designed for higher hydraulic efficiency than probably any machine heretofore built, thus approaching the crest of the efficiency curve. The overload capacity of the machine is small, or in other words, the amount the turbine is by-passed when the secondary valve opens is small, and the velocity ratio, therefore, is very little lower when full steam pressure is applied to the secondary inlet than when such pressure is applied to the primary inlet. Further, the hydraulic efficiency is nearly the same, so that the Rankine cycle at 32,000 kw. should not be more than 1 per cent lower than at the point of best efficiency, viz., 26,000 kw. The efficiency at the intermediate overload, say, 30,000 kw., is somewhat worse than this,

TABLE 3 CONDENSER TEST, SUMMARY OF RESULTS

PRESSURE AT THROTTLE, ABS.	220 LB. PER SQ. IN.	15.466 KG. PER SQ. CM.
TEMPERATURE AT THROTTLE.	487 DEG. FAHR.	252.8 DEG. CENT.
SUPERHEAT	97 DEG. FAHR.	54 DEG. CENT.
LOAD, AV. KW	31233	
EXHAUST VACUUM	28.61 IN. HG.	726.69 MM. HG.
EXHAUST PRESSURE, ABS.	1.39 IN. HG.	35.31 MM. HG.
CORRESPONDING TEMP.	89.4 DEG. FAHR.	31.9 DEG. CENT.
MEAN TEMP. DIFFERENCE (LOG.)	12.9 DEG. FAHR.	7.17 DEG. CENT.
HEAT TRANSFERRED PER HOUR	316,000,000 B.T.U.	79632000 LARGE CALORIES
HEAT TRANSFERRED PER UNIT SURFACE PER HOUR	6,330 B.T.U. PER SQ. FT.	17150 LARGE CALORIES PER SQ. METER
HEAT TRANSFERRED PER UNIT SURFACE PER HR. PER DEG. M.T.D.	490 B.T.U. PER SQ. FT.	2390 LARGE CALORIES PER SQ. METER
AIR LEAKAGE PER MIN.	16.88 CU. FT.	478 CU. DM.
CONDENSATE PER HR.	357,060 LB.	161962 KG.
TEMP. OF HOT-WELL WATER.	86 DEG. FAHR.	30 DEG. CENT.
TEMP. OF INTAKE WATER.	70.8 DEG. FAHR.	21.5 DEG. CENT.
TEMP. OF DISCHARGE WATER.	80.9 DEG. FAHR.	27.2 DEG. CENT.
RISE	10.1 DEG. FAHR.	5.7 DEG. CENT.
CIR. WATER PER MIN.	64700 GAL.	243890 LITRES

for while the blading and hydraulic efficiencies remain as high there is a loss due to a certain portion of the steam expanding through the secondary valve to a lower pressure without doing work."

A number of tests were made upon the condensers and auxiliaries, separate and individual guarantees having been made upon the condenser proper, circulating pumps, dry vacuum pumps and hot well pumps. Publication of the test data upon the pumps would simply show good efficient performance without unusual features. The results of the tests upon the condenser have been given, however, simply as a matter of information and interest in connection with the installation as a whole. The guarantees were based upon operation under maximum load, viz., about 32,000 kw., and the test was made with the turbine carrying as near that load as was possible. The duration of this test was three hours, the preliminary operation under test conditions, half an hour. The results have been shown in Table 3. No corrections were made in this test, as operating conditions approximated the guaranteed conditions very closely, with the exception that air leakage was high. The tests were made very shortly after the installation of the machine and little opportunity had been given under operating requirements properly to eliminate this leakage, which has since been done. A permanent gasometer has recently been installed in connection with each unit, in order to observe air leakage at regular intervals and aid in its elimination.

Summarizing the results of these tests, it may be said that the performance in the case of both turbine and condenser showed higher efficiencies than was guaranteed under contract, and the installation has proven to be thoroughly satisfactory in every particular, having fully realized the considerations which governed its selection.

DISCUSSION

HENRY G. STOTT. I think it may be of interest for me to make a few historical remarks. The station in which this apparatus is located was designed about the year 1900, so that from that time until the present represents a period of about sixteen years. This installation illustrates very well the tremendous evolution of the art in that brief period.

Sixteen years ago the turbine was hardly heard of in this country; only a few practical experimental sets had been installed, and the large engines which were then designed for the Allis-Chalmers Company by the late Mr. Reynolds, became known as the Manhattan type engine. That engine, as some of you may recall, consisted of a horizontal high pressure cylinder connecting on to a vertical low pressure cylinder, at right angles on the same crank pin. Then on the other side of the generator was a duplicate set. Only two cranks were required for four cylinders.

These engines established an enviable reputation for reliability. Their economy was as good as could be expected in reciprocating engines at that time, with comparatively moderate pressures of about 175 lb. and no superheat. The valves were the regular Corliss type.

It is an interesting fact to recall about what these units cost. They were 5,000 kw. rating, with a maximum overload capacity of 50 per cent, bringing up the maximum load to 7,500 kw., which they would readily carry, but with correspondingly poor water rates. The water rate of the engine on test ran over 17 lb. per kw-hr., and that was considered a very good record. The cost of these units, for the engine, generator and condenser, was a little over $40 per kw. capacity, based on the rated capacity. To contrast that with what has been installed in place of them is rather interesting.

To go back just for a moment to the original plant. It was designed on what was practically a unit basis, as far as the engines and boilers are concerned, that is to say, there was a group of eight 520 h.p. boilers per unit, and each unit could be operated independently of the rest of the plant, but normally was operated with all the boilers connected together through two headers. The boiler capacity, therefore, was 4,160 boiler h.p. for a 5,000 kw. unit.

In place of the engine, the new unit was installed, the test of which is described in the paper,—a 30,000 kw. unit, cross-compounded, the high-pressure turbine, running at 500 r.p.m., exhausting into a low-pressure turbine running at 750 r.p.m., and that unit of 30,000 kw. capacity was placed between the same centers as the 5,000 kw. unit we took out. The cost per kilowatt of the modern unit, including condensers, I think was a little over $9, as compared with $40, in the first place.

You see that we put in the same space a 30.000 kw. unit in place of a unit having a maximum of 7,500 kw., or 5,000 kw. economic rating, for the efficiency curve of the engine took on approximately the shape of a V, so that it did not pay to run the units very much over the rated capacity of 5,000 kw.

The plant which has been put in place of it is operated by the same eight boilers, that is to say, the boiler capacity has not been increased, except to put in underfeed stokers under the boilers, so that we have simply changed a 5,000 kw. unit to a 30,000 kw. unit. That is about six to one increase in capacity, on the same number of boilers. Of course, this is being accomplished by correspondingly low water rates, as shown in the test described in the paper.

The improved water rate is obtained through the more economical turbine and through the use of the superheat, so that the actual water rate, discounting the superheat, is, with the present unit on the average of about 12 lb., as compared to about 17.5 on the average with the previous unit. We therefore have here a very good illustration of the enormous

progress which has been made in fifteen years in the art of developing steam motors.

The advantages which have been procured are, first, in the same floor space we get six times the capacity at a cost per kilowatt of approximately one-fifth of the original unit; and, what is still better, the water rate, when reduced to saturated steam, has been reduced approximately fifty per cent. That is an enormous gain, and I think we ought to feel very much gratified at the wonderful development which has taken place in the steam engine as a prime mover.

The progress of the steam turbine has been so great that to-day it has practically displaced the gas engine. If you will look at the thermal efficiency given in the test described in the paper, you will find it runs up to about 25 per cent. That is practically in the same class as the best gas engine practice to-day. So, as the cost of the gas engine unit is probably seven or eight times as great as the turbine unit, the gas engine has been practically put out of the running for large power plant work.

Another very interesting sidelight in this matter is the value of the installation as a general prime mover in competition with anything else that could be cited. Fifteen years ago hydroelectric power developments were looked on as a choice investment, worth lots of money at almost any cost of development. Waterpowers were developed that cost $200, $250 and $300 a kilowatt. To-day you could not get money for an investment of that kind. Why? Simply because the steam turbine has become so efficient and at the same time decreased in first cost, that it has driven out all possibility of developing a great many of these waterpowers, because when you consider the fixed charges, the steam turbine can make power more cheaply than the high-priced hydroelectric development.

Even take the case of Niagara Falls itself, where there is no dam required, and where there is practically an unlimited supply of power, the steam turbine plant can compete as long as the load factor is less than 60 per cent. The only chance for waterpower development is on high load factor.

These things are all due to the wonderful development in the steam turbine in the last fifteen years. We all probably recollect the first few large units which were developed, and a great many of us were rather doubting Thomasses at that time. The water rates obtained were from 20 to 24 lb. per kw., and it seemed that it was hardly worth while to bother with the turbine. The only thing that seemed in its favor was that it took less floor space and cost less, but to-day that argument no longer applies. The steam turbine has apparently come to stay, for some time at all events, and as far as we can foresee in the future, as our principal prime mover, and its only rival is hydroelectric power when the load factor is large.

FRANCIS HODGKINSON. In the report of these tests one should not be misled by the large scale ordinates employed. The casual inspection of Figs. 7 and 9 would lead one to believe there are many inconsistencies. Both of these figures exhibit two rather curious reverse bends, one occurring between 22,000 and 26,000, the other between 27,000 and 32,000. The latter lends itself to the explanation quoted in the text of the paper.

The reverse bend occurring between 22,000 and 26,000 kw. is not as easily explained. Its existence during the tests was doubted and various errors were suspected. Repetition of the test, however, made it very certain that this vagary actually exists.

It is unfortunate that Fig. 7 did not have total steam against kilowatts plotted thereon because up to the point of best efficiency this should be a right line and hence any irregularities in the test results may be best studied by means of such a line.

Plotting this line through the averages of the test points it is found that the greatest deviation from the right line law amounts to only 0.053 lb. in test No. 4. It was supposed that the behavior of the receiver separator installed between the high-pressure and low-pressure turbine elements was the reason.

It seemed in advance that there was an advantage in the cross-compounding scheme in that there was an opportunity to separate effectively the precipitated water between stages

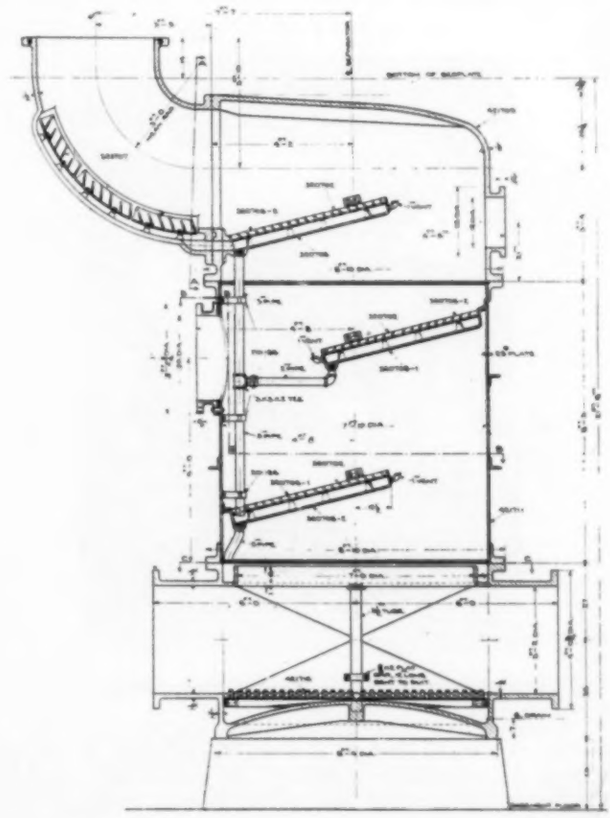


FIG. 15 STEAM SEPARATOR USED IN THE PLANT

and relieve the low-pressure elments of the friction of this inert fluid, and so an attempt was made to provide a satisfactory steam separator between the two turbine elements. Everyone agreed that the most effective separator would be a vessel in which the steam velocities would be lowered to some 20 or 30 ft. per sec. Such a separator was, however, out of the question with the enormous volumes involved. The design of separator finally adopted is shown in Fig. 15, in which the moisture is abstracted by the use of baffles, and to some extent at least by centrifugal force as the steam flows around the curved surfaces at high velocity.

The baffles are hollow boxes with perforations and riffles on their upper side, the interior being piped to the base of the separator to preclude the water once separated being picked up again by the flowing steam; the inlet elbow is similarly treated. The general arrangement of the separator is shown in Fig. 16.

The steam leaves the base of the separator by means of two pipes on either side which join together, subsequently again dividing and entering the low-pressure turbine by means of the two pipes shown on the left, the peculiar arrangement of piping being necessary to give space for the condensers which are located either side of the inlets to the low-pressure turbine.

During the tests calorimeter readings were made of the quality of the steam entering the low-pressure turbine and these seemed to indicate that the separator was effective at minimum and maximum flows with a point of ineffectiveness at moderate flow. It was found, however, that these calorimeter readings were not to be relied upon and in fact any calorimeter readings are difficult to obtain under variable load conditions, because of the heat inertia of the calorimeter parts. Contemplation, however, of the separator makes it

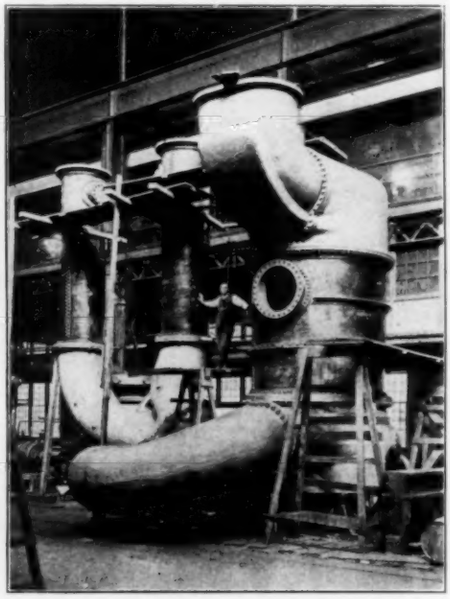


FIG. 16 GENERAL ARRANGEMENT OF SEPARATOR

readily conceivable that with small flow effective separation may be accomplished by virtue of the low velocity; that at large flow, the separator was also effective by reason of centrifugal forces, and that there may be some intermediate and critical point where the water would sweep through without separating.

At the conclusion of the tests the builder's engineers set about an investigation of this separator with a view to eliminating the peculiarity in the test results and generally bettering the performance.

It is unfortunate that on account of the exigencies of power house operation these could not have been brought to a conclusion. These investigations were of course of real interference because the moisture observations were useless except with quite steady loads. It is further unfortunate that only observations of the pressure drop through the separator and the steam quality entering the low-pressure turbine were made and no means were installed for measuring the quantity of water actually separated and discharged to the condenser hot well through the trap.

The observations showed a considerable drop in pressure through the separator and it seemed that an improvement in performance might be obtained by removing all baffles even though this might result in some increased moisture delivered to the low-pressure turbine; the riffle plates at the base of the inlet elbow being replaced with a smooth perforated plate.

Fig. 17 has been plotted showing the pressure drop and moisture in per cent plotted against steam flow both with and without the baffles and it is seen that the removal of baffles not only caused material reduction in the pressure drop through the separator but also a material improvement in separation.

Considering further the matter of the separator, I have had plotted curves, Fig. 18, showing the weight of water going to the low-pressure element; also the calculated quantity of water leaving the high pressure. This is calculated on the assumption of all turbine elements of the complete unit being equally efficient which is not quite technically correct and from the actual steam consumption of the complete unit. The ratio of these two lines is plotted in Fig. 18 and shows the effectiveness or efficiency of the separator.

It is plain, therefore, that were the tests to be now repeated, one to one and a half per cent better results might be expected.

A clause in the contract for these turbines provided that the tests should be carried out with the load variations incidental to the elevated railroad and indeed the load was anything but steady as shown in Table 1, there being load varia-

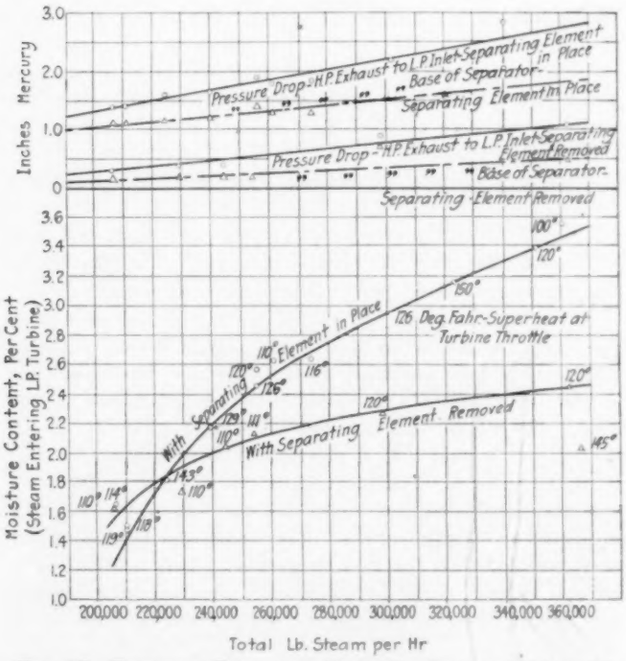


FIG. 17 PRESSURE DROP AND MOISTURE PLOTTED AGAINST STEAM FLOW

tions recorded as high as 69 per cent and single swings as high as 58 per cent—all of which one would suppose would affect the test results quite deleteriously. For while the heat absorbed by the turbine walls during an upward swing is all given back to the steam in a downward swing the heat is taken from the steam when it is at a higher pressure than when it is returned to it, which is of course a direct loss. However, subsequent tests with the governor hobbled did not show any particular difference.

A point of interest in these tests is that between the loads of 21,000 kw. and 32,000 kw., i.e., a range of 11,000 kw., the

variation in steam consumption was from 11.274 to 11.449, a difference of but 17/100 pound.

R. J. S. PIGOTT. It seems almost superfluous to compliment Mr. Stott on the success of this undertaking, as the habit of bringing such engineering feats to a successful conclusion is almost chronic with him.

Referring to the use of two speeds for high- and low-pressure elements, as noted in the paper, the inherent difficulty with the reaction type turbine is that the high-pressure blading is always noticeably less efficient than the low-pressure blading. The hydraulic efficiency of each is probably about the same, but the leakage area over the tips of the high-pressure blades is much greater than the leakage over the low-pressure blades because of the relative shortness of the former. The high speed possible with the high-pressure element makes it possible to reduce the diameter of the drum and at the same time maintain satisfactory blade speeds, and in this manner lengthen the blades for a given annular area; thus, of course, reducing the percentage of leakage area. The gain due to this feature alone is approximately 3 per cent of the total water rate of the unit.

Referring to the use of the individual elements separately in emergency, it is to be noted that in case the low-pressure element is used on by-pass, it must be protected against overspeed in the same manner as the whole unit; therefore, the by-pass was fitted with a 12-inch automatic valve operated from the overspeed governor of the turbine, in the same manner as the main throttle.

Referring to foundations, it is to be noted that in the case of turbine foundations of steel the question of strength is of little importance if the structure has been designed for the allowable deflection, since the foundation is then many times as strong as a normal load-supporting structure. The maximum stresses, disregarding the reinforced concrete envelope, amounted to about 7,000 lb. per sq. in., disregarding the stiffening effect of the reinforced concrete. The increase of strength due to the concrete envelope is about 40 to 45 per cent additional.

The main reason for employing concrete coating was to destroy the excessive harmonic vibration occurring in plain steel structures. It has been found in those plants where uncovered steel foundations are in use (notably the 201st Street Station), that with a turbine equally well balanced, harmonic vibrations are very much more pronounced. The concrete envelope has also an additional function: of protecting the steel permanently against corrosion. The maximum deflection used in designing the steel structure was 0.020 in.

Referring to the condensers and their supports, the unusual feature of this installation is the large amount of movement between the two exhaust openings. In most installations at the present time, a single condenser has been employed, but as the change of length between the centers of the exhaust openings amounts in this case to 0.150 in. between the operating condition and the non-condensing condition, it would be practically impossible to use a single condenser without expansion joints between the turbine outlets and the condenser. In the original design bronze single bellows were used on the piping, there being two 60-in., two 42-in., two 12-in. and a 36-in. It was found, however, that the comparative stiffness of these joints caused the turbine casing to be distorted enough to endanger operation. When it is remembered that one of the 60-in. joints is at a distance of approximately 27 ft. from the center line of the turbine, it is clear that a tremendous leverage is exerted. Some of the joints were tested, and it was found that one of the 42-in. joints took a 32,000 lb. load to compress one-eighth of an inch. It was evident that no metallic joint with a reasonable thickness of shell would be satisfactory. Rubber joints were, therefore, substituted, using the rubber in much the same manner as the bronze had formerly been employed, the cast iron parts being so designed as to give the rubber the maximum degree of support against either pressure or vacuum. As these rubber joints are only used in contact with water, there is no especial danger of oxidation and consequent short life. If any trouble from exterior oxidation should appear, it could no doubt be very readily prevented by shellacing or paraffining the exterior of the joint.

Referring to the return of all waste heat possible, it is to be noted that the return of heat from the oil coolers amounts to nearly 1 per cent of the total heat in the turbine, and the

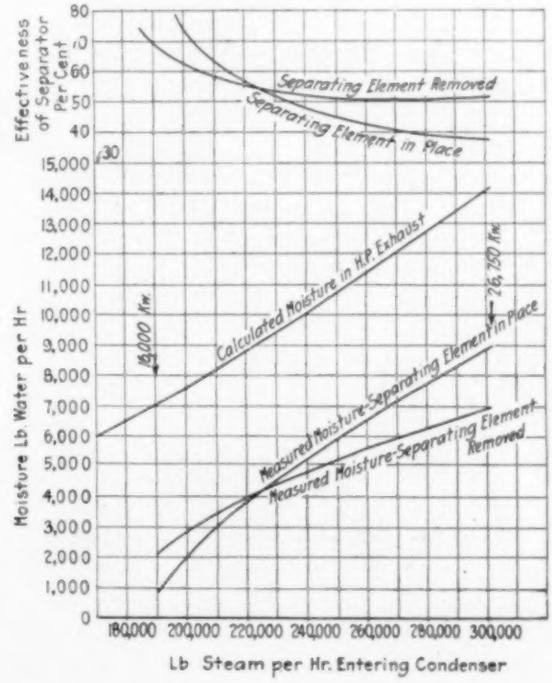


FIG. 18 WATER GOING TO LOW PRESSURE ELEMENT

heat in the air from the turbine generators which amounts to about 1 per cent, is also returned by carrying a discharge duct to the boiler room cellar, where the warm air is used by the forced draft fans. The question of steam or electric-driven auxiliaries was settled by a graphic method of heat analysis covering all loads; in this plant all auxiliaries are steam-driven. The total quantity of auxiliary steam increases very slightly with the load on the main unit; it is, therefore, evident that at light load there will be excess exhaust steam over that required for the feed water heater, and with heavy load there will be too little, the balance occurring at approximately 25,000 kw. on the main unit. The heat balance valve compensates for this feature; at periods of light load it will be noticed that the receiver pressure is less than atmospheric; at such times the excess exhaust steam is free to be admitted into the low-pressure element and there produces a certain amount of power. At high loads, the pressure in the receiver is higher than atmospheric, and the conditions are, therefore, right to deliver steam to the auxiliary exhaust systems as noted. Considering the almost ideally automatic nature of

the above operations, the heat balance valve designed by Mr. Hodgkinson is admirably simple. In the original layout no free atmospheric exhaust was to be provided; ordinary free exhaust being expansive, large sized piping, used a few times during the life of the turbine. It was thought practicable to dispense with it by providing an additional automatic throttle valve controlled by a mercury tripper operated by the vacuum. This tripper was directly connected to the condenser and was in the form of an exaggerated mercury gage; if the vacuum fell below a predetermined amount, say 19 to 20 in., a float in the mercury was lifted, tripping a pilot valve which closed the main throttle. It was also so arranged that in starting up the same method of safeguarding could be employed, operating at 1 to 2 lb. above atmospheric pressure, the device automatically resetting itself for the vacuum conditions, as the vacuum rises in the condenser.

However, the auxiliary exhaust system is of such dimensions that it can be used as an atmospheric relief, merely by enlarging a short section of the line from the turbine to the main exhaust. The old 30-in. engine relief valves were remodeled and the connection was made between the high- and low-pressure cylinder. The loading of these valves which, of course, have to stand pressure at the receiver of as much as 25 lb. absolute, is accomplished partly with a hydraulic cylinder connected to the gland sealing water. In addition, the dashpot on the other side of the valve was ring-packed and connected direct to the condenser, so that were the vacuum lost, part of the load would be automatically removed from the valve, assisting it to relieve the system promptly. As the discharge side of the valve was on the auxiliary exhaust system at 15.5 lb. to 16 lb. absolute, it was automatically steam-sealed; a water seal was, therefore, not absolutely necessary, but was installed as an additional precaution.

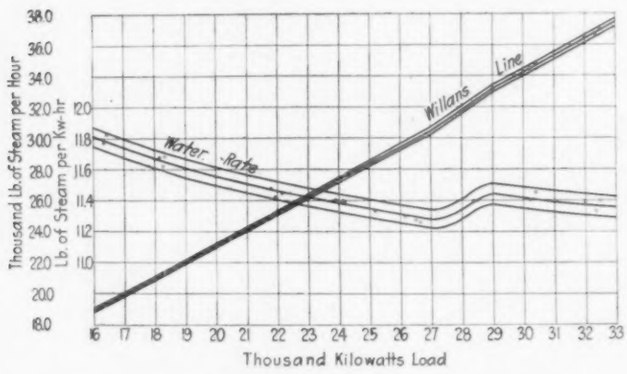


FIG. 19 WILLANS LINE AND WATER RATE FOR 30,000 KW. TURBINE

215 lb. absolute; 120 deg. fahr.; 29 in. vacuum; 30 in. barometer.

Referring to the variation of load during tests, as the Willans line up to best load is straight, and after best load is approximately straight at a different slope, the only point where swinging load would have any effect would be at, or near, the best load, since with a straight Willans line the average water rate for swinging loads is the same as the water rate at a definitely fixed load equal to the average.

Referring to the investigations on the separator: the conditions found were not surprising, considering that practically similar experiences were obtained in the matter of moisture separation from low-pressure steam in connection with the low-pressure turbine at 59th Street, in 1909 and 1910. The first separator installed on No. 1 unit at 59th Street, was about 7 ft. by 14 ft., full of baffles; the results were, practically no separation of moisture. The baffles were removed and it was found that the quality immediately jumped from 92 per cent to 95 per cent or 96 per cent using a plain tank.

Separators Nos. 4 and 5 were designed merely as plain tanks, 8 ft. in diameter and 32 ft. long, containing nothing but protection for the water in the bottom of the separator, and accomplished separation to 99 per cent quality and over. From the consideration of the sizes of these separators, and the amount of steam passed, it appears evident that similar separation is quite out of the question for the 74th Street turbines. It seemed impossible with any baffle separator to remove anything but the water which is running along the sides or bottom of the pipe. The last 2 per cent of "fog" can be removed by only one method, i.e., low velocity (not over

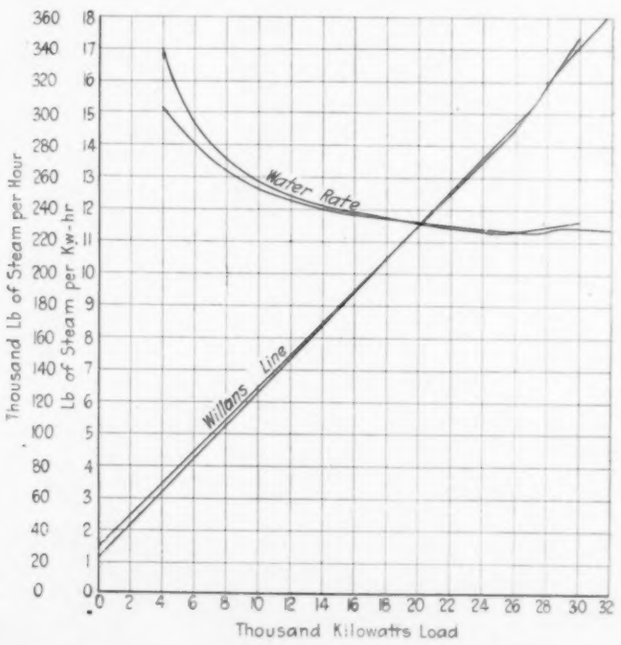


FIG. 20 WILLANS LINE AND WATER RATE FOR 30,000 KW. TURBINE. GUARANTEE AND TESTS

215 lb. absolute; 120 deg. fahr.; 29 in. vacuum; 30 in. barometer.

3,000 ft. per min.), and space, allowing time for the small drops to coalesce into larger drops and rain out by gravity.

Referring to the curve of water rates, Fig. 7, as Mr. Hodgkinson has remarked, some of the curious features of the curve are due to exaggerated scale of the plotting. As he has also pointed out, it is very desirable to make use of the Willans line for fairing the curve. When it is noticed that the total water consumption at any given load may vary 3,000 or 4,000 lb. between different tests, it seems apparent that the unusual curvature represented, up to 26,000 kw., is not justified, but the water rate curve drawn from the straight Willans line will pass just as fairly through the points and give results more in accord with ordinary expectations. Fig. 19 drawn with straight Willans line in accordance with the above shows a maximum variation either side of the average of 0.5 per cent. All of the test points lie within the area of this curve, which is 1 per cent of the total water in width. No commercial tests that have been run up to the present time have ever come closer to the mean than this. It, therefore, seems unnecessary to look for new laws to fit these curves when the old ones fit very well.

Fig. 20 shows how closely the test results follow the general predictions of the guaranteed results. The same objection holds true in some degree to the remainder of the curve, although the first part of the rise from 27,000 to 31,000 occurs very nearly in accordance with the curve obtained direct from the Willans line. It is doubtful if there is such improvement in water rates in passing 31,000, as the curve shows. Mr. Hodgkinson's point that the hydraulic efficiency of this machine is near the crest of the curve is perfectly true, but it must be remembered that when operating at maximum load on the secondary valve, there are only 32 stages in operation, instead of 38, the first eight being entirely blanketed at this time. Therefore, although the hydraulic efficiency of the stages may be as good as at best load, the efficiency could not be quite as good, especially as the first eight stages are revolving idly in high pressure steam, and the exit loss is increased. However, as has already been said, these variations of the curve as drawn, from water rate curves placed back from the Willans line, are really very slight in actual mount.

I think that not only are Mr. Stott and his associates to be congratulated upon these remarkable results which have so closely justified the preliminary calculations, but especially Mr. Hodgkinson for the extraordinary excellence of design which, up to the present date, represents the high water mark of turbine engineering.

FRANCIS HODGKINSON. I would like the privilege of replying to Mr. Pigott's discussion. He refers to the advantage of examining turbine tests by means of plotting total steam against load. This desirability has already been referred to in my previous discussion in which I also pointed out the small amount by which the test points departed from the Willans right line law. The departure from this, however, was nevertheless there and not to be ignored. The tests were repeated too many times for the matter to be relegated to ordinary errors of test.

I do not concur with Mr. Pigott's conclusion as to the effect on steam consumption of the overload valves, that is, valves which permit the turbine to carry greater load by by-passing certain elements of the turbine. The curve of hydraulic efficiency, and by this I mean the efficiency that is the result of relation between steam and blade velocities and blade angles, is of the order of the curve, Fig. 21. With the angles ordinarily employed, the highest efficiency is theoretically reached at about 90 per cent velocity ratio. It is readily conceivable that a turbine might be designed so that the velocity ratio with full steam pressure at the primary admission might be arranged to have a velocity ratio of considerably over 100 per cent. Then with full pressure applied to the secondary admission, the steam consumption might actually be better than with full pressure applied to the primary admission only, if the turbine is operating at somewhere near the same speed in each case. This is a feature which is frequently made use of in marine work in order to obtain high efficiency at cruising speeds. The above, however, does not refer to this specific case as the turbine under discussion is designed for a velocity ratio approximating 75 per cent. The amount of the turbine by-passed by means of the secondary admission is a small proportion of the whole turbine so that the effect on the so-called hydraulic efficiency is small and hence the performance with full pressure on the primary admission only and full pressure on the secondary admission is not materially different, there being intermediary points of poorer performance.

It is customary nowadays for turbines to be sold at a maximum continuous rating corresponding to that of the generator. This, however, has very little to do with the capacity of the turbine itself as the most important thing in the design of the turbine is the capacity at the point of best steam consumption. It is not difficult to provide means of carrying proportionately heavy loads in excess of this at higher steam consumption.

In case of small street railway companies, the point of best steam consumption may be but a relatively small proportion of the maximum rating to enable the power house to carry heavy peaks for brief periods of time. At other power houses, such as the large Edison stations, a maximum load is carried practically all the time the unit is operating, in which case the point of best efficiency should approach the maximum continuous load.

The effect of imposing more load on the turbine than that

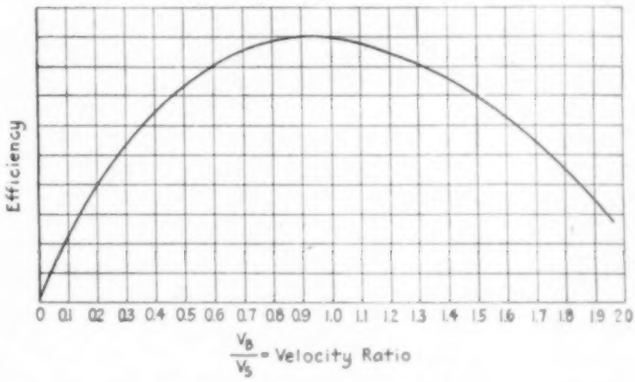


FIG. 21 CURVE SHOWING ORDER OF HYDRAULIC EFFICIENCY FOR TURBINE

due to full steam pressure being applied to the secondary admission or other overload valves, if there be any, is to cause the turbine to slow down. Loads as high as 36,000 kw. were observed during the early operation of these machines, but these were probably in error. The test records show pressures at the secondary admission of 200 and 201 lb. gage respectively for 31,986 and 32,348 kw. respectively.

JOHN P. SPARROW. I cannot add anything to the admirable paper that Messrs. Stott and Finlay have presented to us this evening in the way of either criticism or comment, but in line with Mr. Stott's historical review, I will give a few items in connection with the plant of the New York Edison Company.

Of the two Waterside Stations, one was built in 1900 and one in 1906. The original equipment in those stations was 152-650 horsepower boilers, designed for hand firing, the grates burning No. 3 buckwheat coal. The development that has taken place in turbines and in the high boiler capacities has resulted in an increase in capacity over the original 140,000 kw. to 250,000 kw., and we still have capacity for 100,000 kw. more, with a very moderate boiler rating of 250 per cent, which means we have between 450,000 and 500,000 kw. available boiler capacity if we go to the present day methods of operation.

I would like to ask Mr. Stott, briefly emphasizing Mr. Reinicker's remarks, as to the thermal efficiency of the station. We are interested in large turbines, we are all in-

terested in high boiler capacity, and we have had quoted results of 16, 17, 17¼, and in some cases 17.5 per cent thermal efficiency. As I understand the 74th Street Station, these three units carry practically the entire output of the station, therefore, any figures which Mr. Stott might give us would give us comparison with the best practice that has been quoted up to date.

JOHN W. THOMAS. The author has brought out quite prominently the large capacity it was possible to install in the existing space and on existing boiler equipment. One would infer from his remarks that this was largely due to the increased efficiency of the turbine; whereas, I believe the reason for the increase to be largely due to the boiler room and equipment.

I believe the old station was designed for boilers to operate approximately at rating, and the boiler capacity was put in on this basis. To-day, with the underfeed stoker it is possible to run the boilers at a much higher rating. Mr. Stott gets something like 300 per cent of rated capacity in everyday operation, which, I believe, is the one largest item in the increased capacity of existing equipment.

In line with this, we have just installed at New Orleans a 900 h.p. Babcock & Wilcox boiler, with underfeed stoker, on which, with the ordinary operating crew and in regular operation, we have been able to get 450 per cent. This boiler is a duplicate of twelve other boilers in the plant, which were put in from 1904 to 1908, equipped with overfeed stokers. We find that the new boiler will deliver as much steam to the plant as it is possible to get out of three of the old boilers of exactly the same size.

One gentleman asked the question, "How much coal is consumed in the plant described in the paper?" The coal is burned; that is the province of the underfeed stoker. In the boilers mentioned above, we have been able to burn about 16,000 lb. per hour.

SELBY HAAR asked whether any endeavor was made to use the pitot tube type of steam meter as a check on the methods of measuring the feed water, and Mr. Finlay replied that the venturi type was used but not the pitot, and they checked up very closely; indeed, about one-half of one per cent was the actual variation.

THOMAS N. ROBERTS. What happens to the steam curve when an overload is put on the generator? The rating of the machine is given in kilowatts, and the machine is running, according to the curves, usually something a little above that. The term "maximum rating" has entered into the rating of electrical apparatus in the last few years, and this term would lead us to perhaps apply it also at this point to the turbine, where it falls off in ability to hold up under an added electrical load. The question then arises, if 25 per cent additional to this normal rating is added, in the way of an electrical load, what will happen to the steam and other characteristic curves?

F. W. DEAN.. Mr. Stott has told us that in the case of reciprocating engines, he had 5,000 kw. rated power driven by a certain number of boilers, without superheat, and in the case of the turbine he had 30,000 rated power driven by this same number of boilers with superheat. As a matter of interest, I would like to know how much coal in each case was used per kilowatt-hour.

E. H. FOSTER. It would be interesting to know whether the question of substituting reheaters for the superheaters in the high-pressure turbine was considered.

NORMAN G. REINICKER. In Table 2, I notice that the vacuum decreases with the decreasing load. I was wondering if that was due to increasing air leakage, because in most turbines, as the load decreases, that is, as the quantity of steam to be condensed decreases, the condenser would give better vacuum, because it is running under load.

The paper says that this leakage has been corrected, more or less, and I was wondering what it is at these lower loads, —how fast it increases?

I was also wondering what the station load factor is, and what the economy of the station was with the turbines all running, and using the exhaust steam into the main turbine, and the heat from the generator going back into the boilers. That is what we are interested in in utilizing these large machines in power stations.

HENRY J. STOTT. Mr. Roberts asked what would happen if we added 25 per cent overload on the generator. Of course, obviously, the turbine would begin to shut down. Nothing else would happen except that there would be a reduction in speed. The actual limit of load the unit will carry, without loss of speed, is apparently about 33,000 or 34,000 kw. We have actually carried 32,500 on the test, and maintained full standard frequency, 25 cycles, but beyond that, somewhere between 33,000 and 34,000 kw., the turbine begins to drop in speed. If you added 25 per cent on to the 30,000 kw., you would bring the turbine down somewhere about 15 per cent in speed.

In regard to the coal per kw-hr. on the engines before the turbines were put in at all, mentioned by Mr. Dean, we were running about 2.5 lb. of coal for the plant, averaged at the end of each month. That included, of course, everything, all auxiliaries, coal handling apparatus, and everything else. In other words, the total coal used per month divided by the kw-hr. output, or delivered to the feeders leaving the power house (what we call the net output), would result in a figure of approximately 2.5 lb. of coal per kw. That was before the turbines were put in. Since the turbines were put in, and while they have been carrying practically all of the load too, with the steam mains leading to the engines still alive for emergency purposes, the coal consumption is approximately 1.5 lb., a drop of 1 lb. per kw., as the result of the installation of the big turbines. The thermal efficiency of the station for the monthly average is approximately 17 per cent.

In reply to Mr. Foster regarding reheaters between the high and low-pressure turbines, that practice has been abandoned, as previous investigations in connection with the engines show no improvement, and there is probably none.

Mr. Reinicker asked why the vacuum went down with the load. That is undoubtedly due to air which at that time we were unable to overcome, but later, with more care and experience and the use of a gasometer, we have been able to eliminate that trouble.

I would like to say one word of congratulation to Mr. Hodgkinson, who is the designer of this machine, which is a very radical step in turbine design, and I do not think it would be fair to conclude the presentation of the paper without paying a special tribute to his originality and also the great engineering skill and courage he has displayed in carrying out the design.

SOCIETY AFFAIRS

COUNCIL NOTES

At the meeting of the Council on May 12, 1916, the following were present: D. S. Jacobus, *President,* John H. Barr, R. M. Dixon, *Chairman Finance Committee,* Arthur M. Greene, Jr., Henry Hess, Charles T. Main, Spencer Miller, I. E. Moultrop, *Chairman Publication Committee,* H. de B. Parsons, J. E. Sague, John A. Stevens, Max Toltz, E. H. Whitlock, Wm. H. Wiley, *Treasurer,* and Calvin W. Rice, *Secretary.*

The President reported the appointment of A. T. Brown, Ambrose Swasey, E. J. Armstrong, J. A. Brashear, J. A. Matthews, P. J. Fickinger, E. P. Bates, E. N. Trump, F. G. Tallman, A. W. Smith, W. C. Brown, F. R. Hutton, W. B. Cogswell, H. H. Suplee, Wm. H. Wiley, and F. A. Halsey as Honorary Vice-Presidents to represent the Society at the funeral of John E. Sweet, Honorary Member, Past President and Founder of the Society.

W. H. Bixby, H. A. Gillis, G. M. S. Tait and W. A. E. Doying were appointed as Honorary Vice-Presidents to represent the Society at the Conservation Congress.

J. S. Hyde and H. H. Davis having resigned as Directors of the Industrial Preparedness Census, Messrs. P. M. Hammett and F. P. Fisher were nominated State Directors for Industrial Preparedness for the States of Maine and Oklahoma respectively.

The President announced the appointments of H. G. Stott and H. L. Gantt on the Committee on Standardization, to fill vacancies caused by the resignations of J. H. Barr and Charles Day.

Interpretations of the Boiler Code Committee, Nos. 59 to 66 inclusive, were approved and ordered published; they will appear in the July Journal.

At the request of the Joint Conference Committee of the National Engineering Societies, another member from this Society, Dr. Jacobus, was added to the representatives of our Society, Charles Whiting Baker and Arthur M. Greene, Jr.

A. L. Williston, *Chairman,* C. H. Fish, C. W. E. Clark, A. C. Ashton and W. G. Starkweather were approved as a Section Committee in Boston. J. W. Roe and F. L. Mackintosh were approved as members of the New Haven Section Committee, to succeed L. P. Breckenridge and H. Y. Brewer. The President and Secretary reported having made addresses regarding Society affairs before the Sections in Philadelphia, Buffalo, Providence and that they had planned to address a meeting in Detroit, Baltimore, Chicago, Milwaukee and St. Paul.

Actions of the Executive Committee were confirmed. One of these related to requesting for the Pan-American Committee, through the columns of The Journal, the names of members of the Society who have had actual experience in South and Central American countries.

CALVIN W. RICE, *Secretary.*

NATIONAL SOCIETIES AND LOCAL SECTIONS

An informal discussion was held at the house of the American Society of Civil Engineers, on the evening of April 19, 1916, on the subject:

"What relation should exist between the National Engineering Societies and the local sections or associations of their members, and, in the interests of the profession, what should be the attitude of both of the above to other local engineering societies or clubs?"

By invitation, members of the other three National Engineering Societies were present, and past and present officers and members of these societies gave the history and experiences of the sections of their organizations.

A full account of the discussion appears in the May Proceedings of the American Society of Civil Engineers. Many of the remarks made were of direct interest to our members, and those by Dr. Jacobus, together with a very brief abstract of those by some of the other gentlemen who spoke, are reproduced below.

ELMER L. CORTHELL, PRESIDENT AM. SOC. C. E. (by letter).—In this carefully considered outline plan, the objects kept in view are the *Solidarity* of the engineering profession in the United States and the *Independence* of its individual Society Units.

ELEMENTS

A—"*Joint National Conference Committee*" of the five National Engineering Societies—Civil, Mechanical, Electrical, Mining, and Marine Engineering and Naval Architecture.

B—"*Joint Local Conference Committees*" of the Associations or Chapters of the Societies above named located at population centers of the country (including members in districted areas) constituting a connecting "live wire" with the

C—*Local Engineering Societies.*

SCOPE AND DUTIES OF EACH ELEMENT

1—(A) (Joint National Conference Committee) will embrace all general and National Engineering subjects, problems, and policies, transmitting to (C) (Local Engineering Societies), through (B) (Joint Local Conference Committees) information, and receiving from (C) through the same channel their desires and suggestions.

2—The National Societies, through their Joint Local Conference Committees, will encourage their members to apply for membership in the Local Engineering Societies, and the latter will, through the Joint Local Conference Committees, encourage their members, on the other hand, to apply for admission in the National Societies—and all Societies through the same channel will urge engineers not now members of the Society (the number being considerable) to apply for membership in *some* Society—with the view to consummating effectively the solidarity of the entire Profession, numbering, it is estimated, more than 60,000.

3—*Technical Literature.*—Papers of general, National or international interest to be, generally, presented to the National Societies; but those of Local, Municipal, and State interest to be presented to the Local Engineering Societies—as the former demand a National distribution and the latter a local circulation.

4—All Societies—National and Local—through the intermediary of the Joint National Conference Committee and the Joint Local Conference Committees to work for the promotion, protection, and advantage of every one of its 60,000 members—from the National, State, Municipal, and individual point of view—in matters of legislation—National, State and Municipal—in civic and patriotic measures—in employment of the Engineer and in the publicity necessary and proper to bring to the notice and appreciation of the public at large—and the Natonal, State, and Municipal Governments, the duty, ability, and determination of the Engineer to assert and assume his rightful place in the body politic as a useful, interested and patriotic citizen.

5—The plan above outlined, if carried into full and effective execution, will redound to the public welfare and to the

general and personal advantage of the Engineer, and it will soon prove to the Nation that his fundamental purpose is not altogether to "make a living, but to live a life" of high endeavor and usefulness, and with the motto "*Service and Self Sacrifice.*"

PAUL M. LINCOLN, PAST-PRESIDENT, A.I.E.E., MEM.AM. SOC.M.E.—A point on which we have labored considerably in the local Sections of the American Institute of Electrical Engineers is the matter of coöperation between the local Sections of our Institute and the other engineering bodies in those localities. It is a matter which has been talked over to a very considerable extent, and we have a large amount of experience on it. It has always been my endeavor and aim, so far as I have been able to guide the Sections, to insist that the spirit behind the relations between the local Sections of the American Institute of Electrical Engineers and the other engineering bodies in any locality, shall be one of coöperation rather than antagonism.

Antagonism will never get us anywhere, whereas coöperation is the thing for which we are all striving; so it has always been my endeavor to work for that coöperation. It has always been my feeling that there was no cast-iron way of bringing about coöperation in any local Section, that the methods of bringing about that coöperation were necessarily local problems, and had to be worked out in each locality for itself.

The object, of course, of all these meetings and affiliations among the various engineers and engineering societies is to enhance the value of the engineer in his particular locality, and to give him a wider influence in general, and particularly in civic affairs.

DR. D. S. JACOBUS, PRESIDENT AM.SOC.M.E.—The subject before us to-night, which has been so ably discussed, is one of the most important, if not the most important, before the Engineering Societies at the present time; it is so important that I hope to be able to appear before all the Sections of The American Society of Mechanical Engineers during my term as President in an endeavor to obtain the views of the membership at large.

There was a good representation from the Sections from all parts of the country at the recent meeting of our Society in New Orleans, and in conferring with members from many different districts, it would appear that there is a closer coöperation between the members of the different Sections than there is between the governing boards of the Societies. Our governing boards should get together, and the quicker we do so the better it will be for us. It certainly would be a good move to have a joint meeting of the Committees of the Sections of the several Societies, as suggested by your President, Dr. Corthell.

I agree that there should not be too many restrictions in the management of the Sections, especially at this time when we have not established a definite policy. Every Section has special problems of its own to deal with and must use its own methods. Our management should be broad and such as to inspire loyalty and foster coöperation. I was much gratified in meeting the members of the different Sections to find them enthusiastically in favor of coöperation, and it is, therefore, a most opportune time for the managing boards of our Societies to get together and devise a means whereby this may be accomplished in the best way for all concerned. Our members have shown such a fine example in coöperation that it only needs a little encouragement from headquarters to spread this spirit throughout the country and thereby enhance the interests of the entire profession. I hope, therefore, that Dr. Corthell will call us together without delay.

In addition to the geographical Sections, The American Society of Mechanical Engineers has forty student branches, numbering about 1000 student members. Young men form the life of any society, because later they will fill our places. As we grow older, we appreciate more and more that the capital of youth is a most valuable asset; in managing the affairs of our Societies, therefore, we should keep our young men well in line, for in them lies the future strength of our organizations.

W. L. SAUNDERS, MEM.AM.SOC.M.E., PAST-PRESIDENT A.I. M.E.—The Institute inaugurated the local section policy about five years ago. We have today fifteen Sections, our experience being that a Section is an element of strength, adding a limb to the main body and contributing toward the general interest and prosperity of the Institute. Through Sections the membership is largely increased.

Another advantage derived from Local Sections is that the influence of the Institute may be used through its Sections to benefit the mining industry as it affects different parts of the country.

The policy of the Institute has been to invite representatives from the Local Sections, who may be visiting New York, to attend the meetings of our Executive Committee and Board of Directors. The advice given by members of the Institute coming from different sections of the country has been wholesome and beneficial. It brings them in touch with the policy and the officers of the Institute, and it brings the management in touch with the special conditions which exist in different sections of the country.

C. D. MARX, PAST-PRESIDENT, AM.SOC.C.E.—I think one of the most important things in connection with the local organizations is the social factor. It is good to read papers; it is good sometimes to have papers read to you, but I think it is far better that the men who are doing the work of the world today should be brought together into common contact. You cannot know a man and not like him as a rule, and the fact that, in the past, we have not had the opportunity of knowing our fellow members, of knowing our fellow engineers, working along other lines, has, to my mind, been a serious detriment, and has prevented that recognition of the engineer on the part of the community, which engineers were not even willing to extend to one another.

J. F. COLEMAN, M.AM.SOC.C.E.—The spirit of coöperation among the engineers is surely abroad in the land. It is apparent that many members of the profession in all branches have been giving much thought to this question, and more particularly during the current year.

As it appeals to the speaker, from the practical standpoint, coöperation among engineers might be divided into five general headings:

First.—The coöperation between the National Engineering Society and its members, more especially those whose residences or places of business are remote from Society Headquarters. It would appear that this kind of coöperation may only be brought about by the local sections or chapters which have been mentioned by every preceding speaker. It is highly necessary that the coöperation between the governing board of the National Society and its members should be as complete as it is possible to make it, as otherwise the National Society cannot hope to achieve its fullest usefulness.

Second.—The coöperation of the National Engineering Societies with each other. This is hardly less important than the first kind of coöperation mentioned.

Third.—Coöperation between the National Engineering Societies and Local Engineering Societies.

Fourth.—Coöperation of Local Engineering Societies with each other; and,

Fifth.—Coöperation of local members of National Societies with each other, or, perhaps, it would be better to say coöperation between individual engineers.

The desire for coöperation of the National Engineering Society with its own members appears to be indicated by the organization of local sections or chapters.

The spirit of coöperation between National Engineering Societies and Local Engineering Societies is only beginning to make itself evident. The same may be said of the coöperation of Local Engineering Societies with each other.

GEORGE F. SWAIN, MEM.AM.SOC.M.E., PAST-PRESIDENT, AM. SOC.C.E.—It has occurred to me, in listening to what has been said tonight, that there is a deeper side to all this subject of coöperation, which we all desire to bring about. The object of this is to increase the prestige and the influence of the profession, to get for ourselves all that we can in the way of position and influence and power and wealth, if you like, and also to make our profession of the greatest real use to the community. These are all legitimate objects, for any man or any society or any profession.

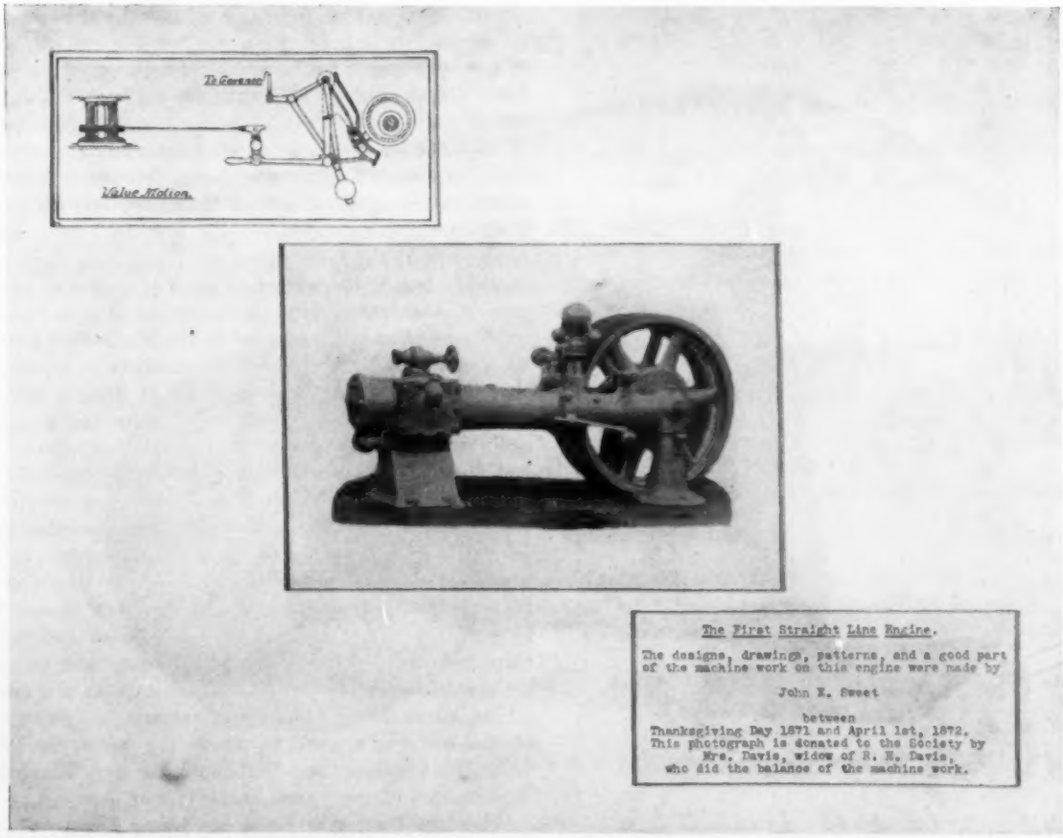
JOHN EDSON SWEET

JOHN EDSON SWEET died suddenly at his home at Syracuse, N. Y., on the evening of May 8, at the age of 83 years. He was the founder of The American Society of Mechanical Engineers, its third President, an Honorary Member, and recipient of the John Fritz Medal for his "achievements in machine design and pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine."

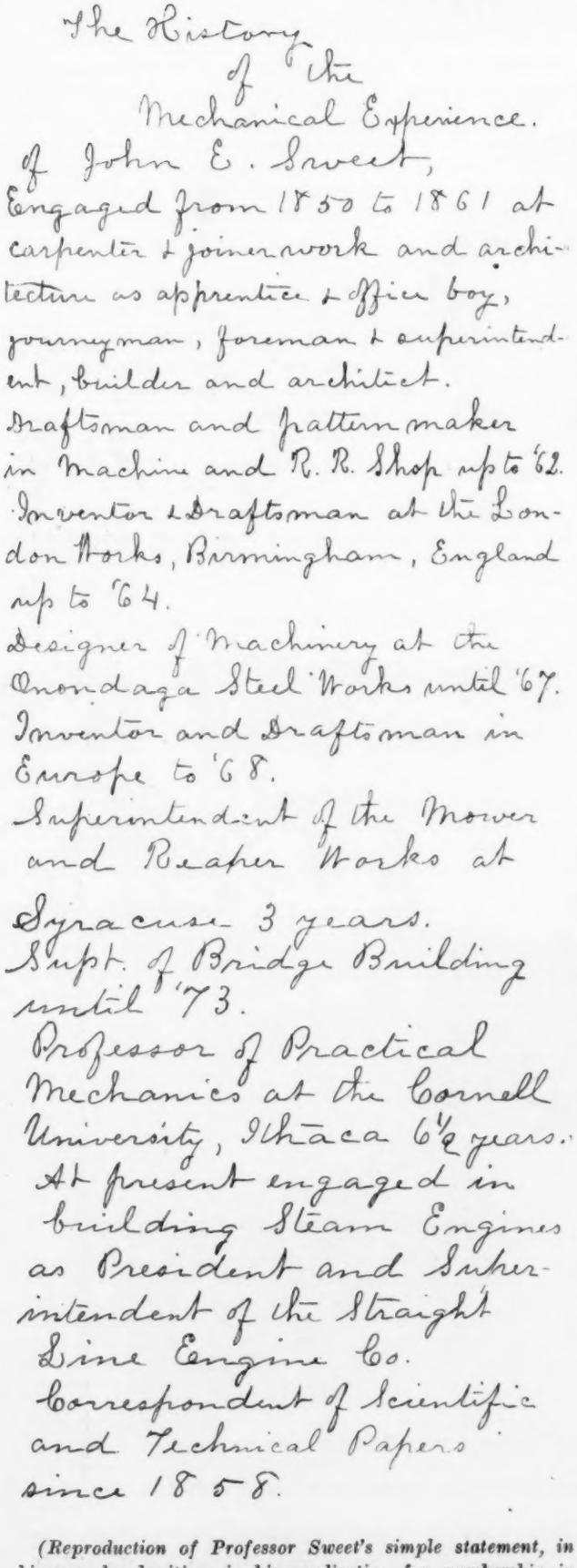
EMBLEM, CHARACTERISTIC OF THE LIFE OF JOHN E. SWEET

Dr. Sweet's prominence as a national figure dates from his connection with the Sibley College of Mechanic Arts of Cornell University, in 1873. His connection with this institution lasted only until 1879, and in that brief period he rose from a position of obscurity to one of prominence, which he ever after maintained. It was a case of the man and the hour. Mechanical engineering as a department of organized education was a new thing. In it there were no precedents, and regarding it there was almost universal skepticism. Its plans, its scope and its aims were unformed even among its friends, and its friends were few. The field was fallow, and into it came, almost by accident, the personality of this untried and unknown man.

His work was two-fold; first, that of a teacher, and second, of a pioneer in mechanical construction. As a teacher, the immediate results of his work will necessarily die with his students, but as a pioneer he laid enduring foundations. Previous experience in England had shown him the fundamental importance of the work of Whitworth, which, because of our then happy-go-lucky methods, had found little appreciation on this side of the Atlantic. Combining an appreciation of Whitworth's advanced standards of accuracy with original conceptions of fundamentally correct principles of construction of a kind far surpassing Whitworth's work, he established a school of construction of far-reaching influence. Along with this went an application of art in design—not the art of ornamentation, but the highest


Valve Motion.
The First Straight Line Engine.
The designs, drawings, patterns, and a good part of the machine work on this engine were made by
John E. Sweet
between
Thanksgiving Day 1871 and April 1st, 1872.
This photograph is donated to the Society by
Mrs. Davis, widow of H. N. Davis,
who did the balance of the machine work.

REPRODUCTION OF PICTURE OF FIRST STRAIGHT LINE ENGINE IN THE ROOMS OF THE SOCIETY



The History
of the
Mechanical Experience.
of John E. Sweet,
Engaged from 1850 to 1861 at
carpenter & joiner work and architecture as apprentice & office boy,
journeyman, foreman & superintendent, builder and architect.
Draftsman and pattern maker
in Machine and R. R. Shop up to '62.
Inventor & Draftsman at the London Works, Birmingham, England
up to '64.
Designer of Machinery at the
Onondaga Steel Works until '67.
Inventor and Draftsman in
Europe to '68.
Superintendent of the Mower
and Reaper Works at
Syracuse 3 years.
Supt. of Bridge Building
until '73.
Professor of Practical
Mechanics at the Cornell
University, Ithaca 6½ years.
At present engaged in
building Steam Engines
as President and Superintendent of the Straight
Line Engine Co.
Correspondent of Scientific
and Technical Papers
since 1858.

(Reproduction of Professor Sweet's simple statement, in his own handwriting, in his application for membership in the Society.)

of all, and in engineering work the only true art, that of perfect adaptation to purpose—that has never been surpassed.

Analysis of a successful teacher's methods is always difficult, and the greater the success the greater the difficulty. Of Professor Sweet's methods there was little organization and less formality. For their prototype we must go back to the schools of the Greek philosophers, who gathered their students about them and taught by a process which was one of absorption rather than acquisition. Without compulsion, students gravitated to him as pieces of iron to a magnet. Those who came under his influence felt that they enjoyed a precious privilege.

Dr. Sweet was born at Pompey, near Syracuse, N. Y., October 21, 1832. His father, Horace, was a farmer and his mother was a member of the well known Avery family, distinguished by its mechanics and inventors. He was educated at district schools and in 1850 was apprenticed to John Pinkerton in the carpentry and joinery trade. When through with his apprenticeship and with $49 in his pocket saved from his meagre earnings he obtained a position in the architect's office of Elijah T. Hayden of Syracuse, in the belief that to become a successful carpenter one must first learn the principles of drafting.

A second winter was spent in the office of C. O. Holyoke, an artist and an admirer of Ruskin, who directed the boy's thoughts to the channel of sound construction and the principle of suiting the construction to the use. He was soon convinced, however, that regardless of how much he might admire art the faculty in his makeup which was worth cultivating was in the direction of mechanics. But to what an extent in later years did he combine so beautifully art with mechanics!

For ten years he was engaged in carpentry and the making of construction drawings for buildings. In that time and place there was small opportunity for the display of architectural talent but nevertheless one of his first pieces of work was a design for a barn which won the first prize in a competition established by the farm paper, the *Rural New Yorker*. It was probably one of the best of its type of buildings ever worked out. A description, with illustrations, and a statement of the conditions of award, appeared in the *Rural New Yorker* in its issue of February 5, 1859. The committee in reporting stated that it "found quite a multiplicity of designs having many excellent features but many were quite too expensive for ordinary farmers and entirely beyond their ability to erect, and only adapted to the able and wealthy who cultivate and embellish their country homes for pleasure and beauty rather than profit." The selection of the Sweet drawings was made, on the contrary, because the barn was "designed to meet the wants of the great majority of farmers as they now exist in the country, adapted not alone to the stock raiser, dairyman or grain grower, but to all these combined and for general farm purposes, including not only beauty and structure but the greatest amount of convenience, cheapness and adaption to all the wants of the majority of farmers." It was prophetic of the architect's work in succeeding years that the prize design was unique and individualistic and adapted to the requirements of the "great majority" of users.

When the Civil War broke out young Sweet was supervising the erection of a hotel at Selma, Ala., which he had designed and which was planned to be one of the best in the South. Being a Yankee he sensed an uncomfortable situation and, as he expressed it, one rainy day he decided to leave while the "leaving was good." Incidentally, this change of location marked a change in his activities, which were thereafter almost entirely in the direction of mechanical construction, engineering, and teaching.

In the summer of 1862 he attended the London Exhibition, spending some months also on the continent and the remainder of the year in the patent office of Hazeltine, Lake & Co., securing a patent on a nail machine in which the Patent Nut & Bolt Co. of Birmingham, England, took an interest. He worked for the latter concern as draftsman while superintending the construction of the machine.

Upon his return to America and again at a later period he was associated with Sweet, Barnes & Co. of Syracuse, where he designed a large number of machines, tools and appliances.

About this time he designed and had built a typesetting machine. It operated like a typewriter, the keys making an impression on a continuous paper pulp matrix, from which the stereotype plates were to be cast. The machine was never perfected but it was one that Dr. Sweet always felt had good possibilities.

In 1867 he again went abroad to attend the Paris Exposition, where his typesetting machine and other appliances were shown.

From 1871 to 1873 he was mainly occupied in bridge building for Howard Soule of Syracuse. In the fall and winter of 1872 he did most of the work of preparing the plans and constructing the first Straight Line Steam Engine; and from 1873 to 1879 was the period with Cornell University.

In connection with this account is a reproduction of a picture of the first Straight Line engine which now hangs in the rooms of The American Society of Mechanical Engineers. This engine was built with a fly ball governor acting upon a peculiar form of link motion.

The second engine, built at Cornell by Dr. Sweet and his students and later exhibited at the Centennial Exposition in Philadelphia in 1876, embodied the combination of a shifting eccentric with a governing weight opposed by a spring, the whole being built into the fly-wheel of the engine. With respect to this Henry Harrison Suplee writes:

> This idea was not original with Professor Sweet as various attempts had been made in Europe to design such a governor, notably by Mr. Arthur Rigg, but all such attempts had been unsuccessful owing to the fact that the action of gravity upon the weight was reversed with every revolution of the fly-wheel, thus producing an oscillating movement which, combined with the varying centrifugal force and the action of the spring, gave an irregular movement which was fatal to precise governing.
>
> In Professor Sweet's design the governor weight was so arranged as to be precisely balanced by the weight of the shifting eccentric and its attached parts so that the only variable force was that of the governor weight which depended entirely upon the speed of the engine, and this made accurate governing possible.
>
> In later years many forms of shaft governors involving both centrifugal and inertia forces were designed but it is believed that in every case the makers of such devices recognized the necessity of using the fundamental principle originally designed by Professor Sweet so that to him the steam engineer is indebted for the successful shaft governor.

The Cornell engine in its essentials was substantially as the machine is built today. It contained the embodiment of the three point self-adjusting support for machines, and is the best exemplification up to the present time of the "straight line" principle in machine frame construction. From time to time niceties of details have been perfected, such as the long cross-head with short guides, one of the principles which Dr. Sweet demonstrated was conducive to long wear, although contrary to the usual practice in machine construction.

FIG. 1 SPEED LATHE BY PROFESSOR SWEET, WITH CHARACTERISTIC FEATURES

FIGS. 2 AND 3 MEDAL AWARDED SIBLEY COLLEGE FOR EXHIBIT INCLUDING STRAIGHT LINE ENGINE

The following notes and photographs in connection with some of his other work at Cornell University have been secured through the kindness of Dean Albert W. Smith.

Fig. 1 shows a small speed lathe built by Professor Sweet in the Sibley Shops about 1877, which shows the characteristic design of supports and the reduction of bed flexure by bringing in the right-hand leg and thus allowing the bed to overhang with a parabolic outline. This last feature was adopted by many machine tool builders soon after that date.

Figs. 2 and 3 are reproduced from a bronze medal in the possession of Sibley College awarded at the Centennial Exposition in Philadelphia in 1876 for the exhibit of the College, time, a unique, shop building was constructed with saw tooth roof, one of the first of its type in this country. The plant has since been somewhat extended and the business has grown normally, never to a large size but maintaining a high grade of workmanship and exemplifying the originality of its head and founder.

As with the engine which was the controlling product of this plant and the design of the building itself, many of the

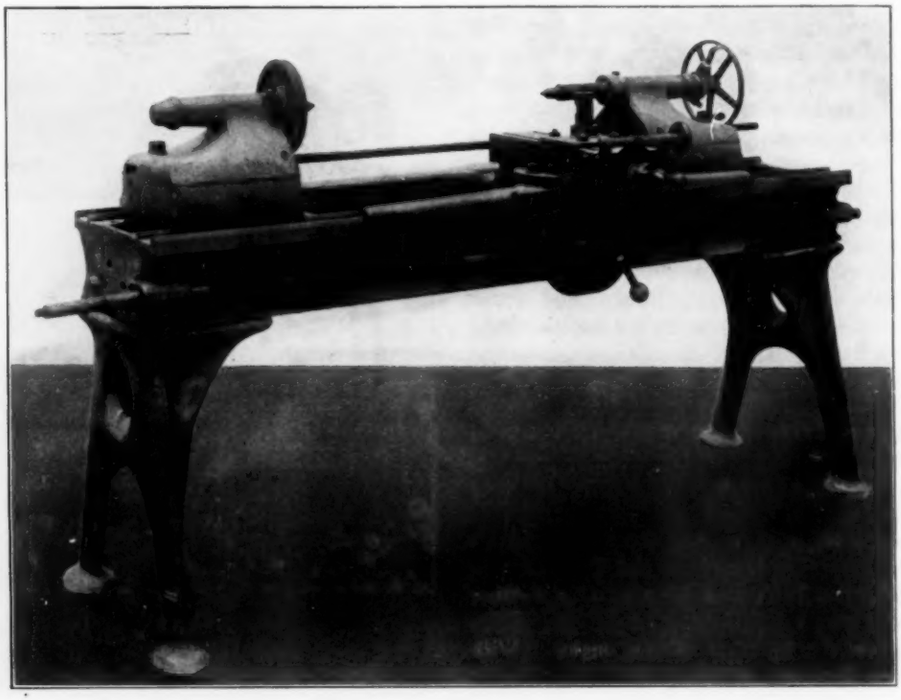


FIG 4 PROFESSOR SWEET'S MACHINE FOR GRINDING CYLINDERS, 1874

which included Professor Sweet's second Straight Line engine, the first one having been built before he came to Cornell. This medallion was placed upon the front wall of the Straight Line Engine Works in Syracuse, N. Y.

Fig 4 is a machine for grinding cylinders, designed and built in the shops of Sibley College about 1874, several years before the Universal Grinder was put on the market by The Brown and Sharpe Mfg. Co. Professor Sweet designed plug and caliper gages, which were ground upon this machine. A set of plug gages, probably the first to be produced in this country, was ground for the Newton & Cox Company, manufacturers of twist drills, of Cleveland, Ohio, in the spring of 1878.

This machine shows the characteristics of the straight lines and oval section of Professor Sweet's designs; also the long bearing surfaces of the wheel-carrying carriage upon the ways of the bed. It is probably the first instance of the use of dead centers both in the head stock and tail stock for grinding surfaces. It will be noted that a bar connects the top portions of the head and tail stock so that when swung for grinding tapers they remain in absolute alignment.

At Sibley College, also, were built the first American-made Gramme dynamo and the well known Cornell measuring machine which F. A. Halsey has said "may almost be called a mechanical classic."

Dr. Sweet resigned his scholastic work at Cornell to engage in the manufacture of his engine at Syracuse. The Straight Line Engine Company was formed in 1880. The business started in a small way in a rented building and a few years later a foundry was added and in 1890 a new, and at that tools, appliances and processes have been of the greatest interest to mechanics and a source of pleasure to those who have accepted the "Visitors Always Welcome" sign over the entrance at its true value and have inspected the plant under the guidance of Dr. Sweet.

One of Dr. Sweet's hobbies was his design of an engine lathe with screw cutting gears in position under the head stock; one of these was built for the Straight Line Engine Company by the students of the University of Wisconsin. The details were so strikingly original that they were described in a series of articles in the *American Machinist* beginning under date of May 30, 1889.

Another machine, which for a better name was designated a "traversing machine," was of the planer type, but with a vertical rotating spindle in place of the usual planer tool. The platen had both a power feed and a quick return by hand. The same was true of the cross rail and of the cross head. The machine was, therefore, capable of doing nearly all kinds of planing, milling, boring or drilling without changes or rearrangement. In an article upon the machine which Dr. Sweet prepared he says characteristically, "The bed is a complete box having solid top and bottom as well as sides, which has been proven by experiment to be 50 per cent stiffer in a vertical direction, 20 times stiffer sideways and 13 times more rigid against torsional strains than the ordinary side plate and cross girder system." The box construction was used for the uprights and the platen as well.

From young manhood Dr. Sweet was a frequent contributor to various journals, and his writings have always displayed that intellectual freedom and clearness which was so characteristic of the man and which, coupled with his lovable nature, gave him so magnetic a personality. During his first trip abroad he contributed letters of travel to a home paper and a series of articles to *The Engineer*. He also prepared manuscripts which later were used by Zerah Colburn when he established London *Engineering*. His best known contributions, however, have been in the columns of the *American Machinist*, to which he contributed frequently, mostly in the way of short articles that were always stimulating in their originality.

It is a pleasant thought that many of Dr. Sweet's greatest pleasures and certainly his greatest satisfactions came to him in the ripening years of his life through his friendships, through his ability to participate in the work of his liking, and in consequence of many recognitions of esteem and appreciation. Perhaps the most cherished recognition was the organization in 1901, by some of his former students, both of Cornell and at the Straight Line Engine Works, of an association of "Professor Sweet's Boys." They were men mostly beyond the meridian of life, who gathered with him year by year on the occasion of his birthday and from long distances, for an annual dinner at Syracuse.

The initial move, made by Dr. Sweet, for the establishment of The American Society of Mechanical Engineers was a letter written January 18, 1880, calling for a conference of prominent men in the mechanical engineering field. The letter read as follows:

11 Eldridge Street, Syracuse, N. Y.
January 18, 1880.

Dear Sir,

It having been suggested by several prominent engineers that a national association of mechanical engineers would be desirable, and a meeting for the purpose of taking steps to organize such a society being in order, your presence is hereby requested at the office of the *American Machinist*, 96 Fulton Street, New York, the sixteenth day of February, 1880, at 1 o'clock sharp, at which time the necessary steps for organizing such an association will be made.

Any inquiries in regard to the meeting will be cheerfully answered.

Please avoid allowing this to be made public.

Very truly yours,

(Signed) JOHN E. SWEET.

Honors were showered upon him, but always against his protest. At the time of the inception of the Society he was offered the presidency, but declined in favor of others whom he—mistakenly and characteristically—considered better fitted for the office; only after considerable pressure would he accept this honor and he served as President of the Society in 1884. He was elected an Honorary Member in 1904, and in 1912 the Society commemorated his eightieth birthday by a dinner at its Annual Meeting; this was the first gathering of this kind in the Engineering Societies Building. In 1914 he was awarded the John Fritz Medal and on January 30, 1914, Syracuse University conferred upon him the degree of Doctor of Engineering.

At the meeting of the Council of the Society, May 12, 1916, President Jacobus appointed the following friends of Dr. Sweet, among them many life-long associates, as Honorary Vice-Presidents to represent the Society at his funeral: A. T. Brown, Ambrose Swasey, E. J. Armstrong, J. A. Brashear, J. A. Matthews, P. J. Fickinger, E. P. Bates, E. N. Trump, F. G. Tallman, A. W. Smith, W. C. Brown, F. R. Hutton, W. B. Cogswell, H. H. Suplee, Wm. H. Wiley, and F. A. Halsey.

AN INTERESTING ANNOUNCEMENT

The Warner & Swasey Company, of which Ambrose Swasey, Past-President of the Society and donor of the initial gift to The Engineering Foundation, is president, and Worcester R. Warner, also Past-President of the Society, is vice-president, announces the completion of the 72-in. reflecting telescope designed and constructed for the Dominion Astronomical Observatory, Victoria, Canada.

This telescope is the largest completed instrument in existence. The block of glass for the reflector was started over from Antwerp about a week before the European War broke out, and work on the reflector has progressed without delay since that time.

When completed, the 100-in. reflector for the Mount Wilson Observatory will be the largest. Work on the installation of this has been delayed on account of inability to procure the tremendous steel members required for the observatory. It is believed that this big telescope will enable us to photograph one hundred million new stars!

In connection with the names of our distinguished members who have carried to successful completion this marvellous piece of work, it is appropriate to mention that of Past-President Brashear, whose most signal achievement has been in connection with the design and development of the spectroscope for astronomical uses, and who completed in 1888 the spectroscope for the 36-in. telescope of the Lick Observatory.

CONFERENCE COMMITTEE

The Joint Conference Committee of the National Engineering Societies has been increased by adding one member from each of the five constituent societies. President Jacobus has been added to the representatives of our Society, Charles Whiting Baker and Arthur M. Greene, Jr.

ENTHUSIASM IN BALTIMORE

Initial meetings of members of the Society in Baltimore to consider petitioning for a Section there, and also of the students in the engineering department of Johns Hopkins University with respect to forming a student branch, were held on May 24. The former meeting was held at the Engineers' Club and the latter at the University. Calvin W. Rice, Secretary of the Society, was present at both meetings and was gratified to find splendid interest.

Johns Hopkins University does not specialize in its courses until the senior year, and it has, moreover, a live engineering society, consequently it is not easy for the students to determine previous to the senior year whether or not they wish a student engineering branch of a national society. There was so much enthusiasm shown at the student meeting, however, that a committee was appointed by Prof. A. G. Christie, the chairman of the meeting, to make a preliminary organization and report in the fall.

At the meeting of members in the Engineers' Club, the Secretary reviewed the history and growth of sections of the Society. He emphasized the fact, as he has done in each of the cities where there is a local club or engineering society, all efforts should be made to build up the local engineering society, and that only after that has been assured may any thought be given to the national societies—that the object of a Section of the national society is to enhance jointly the local society by bringing to it not only the interest of the members

of the national society who are not members of the club, but also the financial contribution which the national societies make for the holding of section meetings. The aggregate of these contributions from all of the national societies would make a substantial increase in the income of the local societies and, in the second place, the burden of maintaining an engineering center would be distributed.

RESEARCH COMMITTEE

The following communication from the Chairman of the Research Committee to a member is of interest as bringing out clearly the objects of this important Committee, as well as giving the present status of the Committee's work:

The object of the Research Committee is to promote the investigation and phenomena, operations, or results of experiments concerning fundamental laws on which engineering practice is based, and to place such data in permanent and basic form. The general committee meets at stated intervals to consider suggested research subjects and to appoint subcommittees to do the actual work of research. Generally, the chairman of the sub-committee is a member of the general committee, but not necessarily so. The present sub-committees are those on fuel oil, materials of electrical engineering, safety valves, worm gears, lubrication, clinkering of coal, steam flow meters, laboratory systems and methods; and a committee on investigation of machine tools is under consideration.

The chairmen and members of the sub-committees either carry on research in their particular field, themselves, by coöperation with manufacturers, or else to have the work done by an interested manufacturer. In general, the expense of the research is borne, therefore, by the interested parties and not by the Society.

Up to the present time the committee has not presented any final reports, but the work on worm gearing is well under way, and also that on steam flow meters, the writer being, incidentally, chairman of this committee. As research work is usually lengthy final reports in less than two or three years are not to be expected. As noted in the definition of the activities of the committee, the work may consist in some cases merely of collation of existing data and putting it in usable form, rather than original research.

BOILER CODE AND COTTON MANUFACTURERS

By invitation of the National Association of Cotton Manufacturers, S. F. Jeter, Mem. Am. Soc. M. E., and member of the Boiler Code Committee, read a paper on the Boiler Code of The American Society of Mechanical Engineers before the meeting of the Association in Boston, April 26 and 27. The paper dealt with the need of uniform rules governing the construction of steam boilers throughout the United States and why the users will benefit by such uniformity. It further showed how the A. S. M. E. Boiler Code meets this need.

After the reading of the paper the Association passed the following resolution:

WHEREAS, The American Society of Mechanical Engineers, having prepared a satisfactory code for the standardization of boiler construction to promote safety of human life and economy in operation,

IT IS HEREBY RESOLVED, that the Association approves the said boiler code and recommends its adoption by states and municipalities where boiler laws are in force or may be enacted.

PAN-AMERICAN COMMITTEE REQUEST

The Pan-American Engineering Committee of the National Engineering Societies, recently organized for the promotion of greater engineering and scientific intercourse and the general welfare of the engineering profession in Latin America and the United States, requests a list of members of the four national engineering societies who have had actual experience in South and Central American countries, and those members of our Society who have had such experience are invited to send their names to the Secretary of the Committee, M. P. Lavis, 50 Church St., New York City, together with the names of the countries with which they are familiar.

The purpose of this request is to acquire information and data which may be of use to the committee in formulating its plans.

MILITARY ENGINEERING LECTURES

The movement for the provision of free lectures on military engineering subjects spread last month to Pittsburgh, where, under the auspices of the Engineers' Society of western Pensylvania, Lieut. Col. F. R. Shunk, Major P. S. Bond, Major J. C. Oakes, and Capt. C. L. Sturdevant, all of the Corps of Engineers, U. S. Army, and Arthur L. Humphrey, Mem. Am. Soc. M. E., vice-president of the Westinghouse Air Brake Company, have given five lectures. The subject of Mr. Humphrey's lecture was Mobilization of Material and Industrial Resources. Elmer K. Hiles, Mem. Am. Soc. M. E., secretary of the Engineers' Society of Western Pennsylvania, superintended the arrangements for the lectures.

The Committee on Military Engineering Lectures in New York, J. Waldo Smith, Mem. Am. Soc. M. E., *Chairman*, announces that as a result of the lectures given under the auspices of this committee an Engineers' Training Battalion of about 500 men has been organized with a view to its members qualifying for an Engineer Reserve Corps. These men have been drilling twice weekly at the local armories under the instruction of the National Guard officers. About 270 members have enrolled for the Plattsburg camp.

Major General Wood has consented to review the battalion on June 1. The Committee believes that the organization and training of this battalion is one of the most valuable results of the military engineering lectures.

PREPAREDNESS PARADE

A unique demonstration in favor of preparedness in the form of a great citizens' parade was held in New York City on May 13. The parade was reviewed by Mayor Mitchel, Major General Wood and Rear Admiral Usher. Over sixty trades and professions took part, and there were upwards of 125,000 citizens in line.

Engineers were invited to parade as *engineers*, and contingents of civil engineers, mechanical engineers, electrical engineers and mining engineers were formed. In all seven thousand engineers, members of the national engineering societies and others, took part.

The arrangements for the Engineer's Division were under the auspices of the Military Engineering Lectures Committee, J. Waldo Smith, Mem. Am. Soc. M. E., *Chairman;* the Marshal of the Engineers' Division, Merritt H. Smith; the Recruiting Committee, Charles Warren Hunt, *Chairman* and the Parade Committee, Arthur S. Dwight, *Chairman.*

The Engineers Society of Buffalo, at its final meeting of the season, held on May 4, reëlected all its present officers, John Younger, Mem. Am. Soc. M. E., president; W. A. James, Mem. Am. Soc. M. E., and Jesse G. Melendy, Mem. Am. Soc. M. E., vice presidents; Wm. J. Gamble, Mem. Am. Soc. M. E., secretary, and William M. Dollar, Mem. Am. Soc. M. E., treasurer.

APPLICATIONS FOR MEMBERSHIP

TO BE VOTED ON AFTER JULY 10, 1916

Members are requested to scrutinize with care the following list of candidates who have filed applications for membership in the Society. These are subdivided according to the grades for which their ages qualify them and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into Membership by advising the Secretary promptly of any one whose eligibility for membership is in any way questioned. All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote. Unless objection is made to any of the candidates posted by July 10, 1916, and providing satisfactory replies have been received from the required number of references, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary about August 15, 1916.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

ARISON, EDGAR E., Vice-President,
The Emerson Co., New York

BENHAM, WEBSTER L., Ch. Engr.,
The Benham Engrg. Co., Oklahoma City, Okla.

BLONCK, W. A., Pres.,
W. A. Blonck & Co., Engrs., Chicago, Ill.

BRADFORD, JAMES S., Insptr.,
E. I. du Pont de Nemours & Co., Wilmington, Del.

BUNZEL, ERVIN, Designer, Power Plant,
Armour & Co., Chicago, Ill.

BUTLER, JOSEPH F., Advisory Asst. to Purchasing Agent,
Nichols Copper Co., Bayside, L. I., N. Y.

CRANE, HOLDEN I., Industrial Engineer,
W'th E. M. Chace, Cincinnati, Ohio

CRANE, R. T., Jr., Pres.,
Crane Company, Chicago, Ill.

EASON, JOHN J., Asst. Supt., Mech. Div.
Panama Canal, Balboa, C. Z.

EGGERT, WILLIAM H., Supt. Construction,
Zaremba Co., Buffalo, N. Y.

ELLICOTT, CHARLES R., Assistant Eastern Manager,
Westinghouse Air Brake Co., New York

FALK, HAROLD S., Genl. Supt.,
The Falk Co., Milwaukee, Wis.

FARQUHAR, PERCIVAL, President,
Brazil Rwy. Co., New York

HAMILTON, ERNEST A., Asst. Mgr. Sales,
Nelson Valve Co., Philadelphia, Pa.

HARPER, HERBERT D., Instr. in Elec. & Mech. Design,
Board of Education, Vocational School for Boys, New York

HILDEBRAND, HARRY D., President,
Hope Engineering & Supply Co., Pittsburgh, Pa.

HOGLE, JAMES A., Consulting Mining Engineer,
Salt Lake City, Utah

HUPFEL, ADOLPH G., Treas.,
The J. C. G. Hupfel Brewing Co., New York

INGRAHAM, ALEXANDER, Pres.,
Williford Mfg. Co., Minneapolis, Minn.

JOHNSON, EADS, Cons. Marine Engineer and Naval Architect,
New York

KRIEGER, ARTHUR H., General Manager,
Kieselguhr Co. of America, New York

LANGFORD, GEORGE, General Superintendent,
American McKenna Process Co., Milwaukee, Wis.

LEARY, GEORGE, Pres. and Genl. Mgr.,
Morris & Cumings Dredging Co., New York

LEINERT, WENZEL, Consulting Engineer, New York

LEONARD, HARRY S., Vice-President,
Winchester Repeating Arms Co., New Haven, Conn.

LUBBERT, GEORGE L., Operating Engr.,
Filtration Plant, City of Baltimore, Md.

NEWSOM, HORACE H., Factory Manager,
Perfection Spring Co., Cleveland, Ohio

PANCOAST, JOSEPH D., Asst. Supt. Construction,
Zaremba Co., Buffalo, N. Y.

POULTNEY, EDWARD C., Machine Tool Dept.,
British Ministry of Munitions, New York

ROBINSON, EDWIN W., Pres. and Genl. Mgr.,
Punxsutawney Fdy. & Mch. Co., Punxsutawney, Pa.

ROBINSON, BARTON J., Proprietor and Manager,
B. J. Robinson's Machine Wks., Vicksburg, Miss.

SCARFE, GEO. E., Cons. Eng., Nevada City, Cal.

SCHLOSS, NEWTON L., Cons. Mech. and Elec. Engr., New York

SIMMONDS, JOHN D., President,
Simmonds Engineering Co., Iola, Kan.

SKINNER, JOSEPH A., Treasurer,
William Skinner & Sons, Holyoke, Mass.

STANSFIELD, FRANK H., Supervisor of Eff. Work,
Bridgeport Brass Co., Bridgeport, Conn.

SWAN, ERVIN D., Mechanical Engineer,
Lidgerwood Mfg. Co., New York

TAURMAN, ALPHONSO, Supt. Rolling Stock,
Virginia Rwy. & Pwr. Co., Richmond, Va.

THOMPSON, ISAAC T., Testing Engineer,
The American Well Works, Aurora, Ill.

TUPPER, FREDERICK G., Assistant Engineer,
South-Eastern Underwriters' Assoc., Atlanta, Ga.

TWOMBLY, ALEXANDER H., Sanitary and Industrial Engineer,
Twombly & Henney, Engrs., New York

VAN GIESON, WICKLIFFE B., Special Draftsman,
Celluloid Co., Newark, N. J.

FOR CONSIDERATION AS ASSOCIATE-MEMBER OF JUNIOR

AMORY, CLEMENT G., Treas.,
Gas Engine & Pwr. Co. and Chas. L. Seabury & Co. Cons., New York

BOARDMAN, ALBERT J., Supt.,
Terre Haute, Indianapolis & Eastern Traction Co., Indianapolis, Ind.

BOWMAN, MARK C., Lieut. (JG),
United States Navy, Washington, D. C.

CUNNINGHAM, FRANCIS, Mechanical Engineer,
with John A. Stevens, Cons. Engr., Lowell, Mass.

CUTLER, MAX E., Ch. Engr. of Works,
Whiting Mfg. Co., Bridgeport, Conn.

DAVIDSON, WILLIAM A., Engineering Department,
The Singer Mfg. Co., South Bend, Ind.

EASTON, LYNN B.,
with Henry R. Worthington, St. Louis, Mo.

EKSTROM, HUGO L., Asst. Supt.,
H. C. Dodge, Boston, Mass.

FITZ PATRICK, WILLIAM J., Head of Wood Work Dept.,
Scranton Tech. H. S., Scranton, Pa.

GUTEKUNST, FREDERICK, Superintendent,
Eddystone Ammunition Co., Eddystone, Pa.

HAYS, LEWIS T., Tramway Engr.,
U. S. Steel Products Co., Pacific Coast Dept., Seattle, Wash.

HICKERSON, GEORGE A., Supervising Engineer,
McKesson & Robbins, New York

KATZ, EDGAR J., Asst. Ch. Engr.,
De La Vergne Mch. Co., New York

KLAER, HENRY J., Treasurer,
Rost Wetherill & Co., Inc., Chester, Pa

LAKE, CHARLES W., Draftsman,
H. Mueller Mfg. Co., Decatur, Ill.

LANG, JOHN B., Director,
Messrs. John Lang & Sons, Glasgow, Scotland, and with British Ministry of Munitions, New York

LEONHARD, ALBERT T., Mechanical Engineer and Secretary,
The Paterson Parchment Paper Co., Passaic, N. J

MIKESH, MARTIN A., Designer,
Fairmont Gas Engine & Rwy. Motor Car Co., Fairmont, Minn.
MONKS, TOM N., Safety Engineer, Portland, Ore.
NOLAN, JOHN H., Operating Engineer,
General Chemical Co., Bayonne, N. J.
NORTON, EDWIN K., Manufacturer,
Standard Tin Plate Co., Canonsburg, Pa.
OLSON, GUSTAF B., Special Experimenting,
Remington Arms & Ammunition Co., Bridgeport, Conn.
PLANK, WILLIAM J., Draftsman, Mech. Div.,
The Panama Canal, Balboa, C. Z.
RHAME, FRANK P., Engineering Examiner,
Municipal Civil Service Commission, New York
SCHMIDT, BRUNO M., Asst. Ch. Draftsman,
Winchester Repeating Arms Co., New Haven, Conn.
SCHULTZ, CHARLES H., Engineer,
The Hero Manufacturing Co., Philadelphia, Pa.
SCHUMACHER, JOHN A., Safety Engr.,
Prudential Casualty Co., Indianapolis, Ind.
STRIPE, WILLIAM C., District Stoker Engineer,
Westinghouse Elec & Mfg. Co., Pittsburgh, Pa.
WARBURTON, ROBERT L.,
with Kieselguhr Co. of America, New York
WEBB, CLIFFORD L.,
with Henry R. Worthington, St. Louis, Mo.
ZINK, ROBERT E., In charge of Design,
Leonard Construction Co., New York

FOR CONSIDERATION AS JUNIOR

BORDWELL, RALPH L., Supt. Constr.,
Sulzberger & Sons Co., Chicago, Ill.
BOYD, HUGH M., Assistant Engineer,
Punta Alegre Sugar Co., Caibarien, Cuba
BRESLAV, JACK,
with Terry Steam Turbine Co., Hartford, Conn.
BULTMANN, ROBERT A. W., Draftsman,
American Products Co., Long Beach, Cal.
COLVIN, CHARLES H., Engr., Aeroplane Dept.,
Sperry Gyroscope Co., Brooklyn, N. Y.
DEW, DONALD H.,
with Remington Typewriter Co., Syracuse, N. Y.
GOOD, EDISON B., Student,
University of Colorado, Boulder, Colo.
HAVILAND, JOHN R., Asst. Ch. Draftsman,
L. O. Koven & Bro., Jersey City, N. J.
HOSKINS, STEPHEN P., Instr., Mch. Design and Mech. Drawing,
West Virginia University, Morgantown, W. Va.
KEES, DANIEL, Vice-President and Superintendent,
F. D. Kees Mfg. Co., Beatrice, Nebr.
KIMMEL, ALFRED W., Mechanical Engineer,
The Platt Iron Works Co., Dayton, Ohio
KNERR, LEWIS E., Mech. Draftsman, Mech. Div.,
The Panama Canal, Balboa, C. Z.
LINDBERG, GEORGE I., Asst. Ch. Mech. Engr.,
Pickands, Mather & Co., Duluth, Minn.
LUDEMANN, JOHN E., Assistant to Engineer of Tests,
New York Edison Waterside Stations, New York
McCLINTOCK, CLYDE H., Student,
University of Colorado, Boulder, Colo.
MORCH, JOHN J., Student,
Columbia University, New York
NATHAN, HERBERT P., Draftsman,
with John H. Murphy Iron Works, New Orleans, La.
POLEK, JOSEPH, Genl. Foreman, M.M. Drawing Dept.,
Cartridge Shell Dept., E. W. Bliss Co., Brooklyn, N. Y.
QUAST, WALTER F.,
U. S. Naval Experiment Station, Annapolis, Md.
RAINEY, CHARLES S., Inspection Foreman,
Remington Arms Co., Eddystone, Pa.
ROSS, HENRY B., Mechanical Draftsman,
Sargent & Lundy, Chicago, Ill.
RUPRECHT, WALTER E., Secretary and Treasurer,
Charles F. Mattlage & Sons, New York
SAWYER, WILFRED D., Student,
University of Colorado, Boulder, Colo.
SEYBOULD, EUGENE, Assistant Foreman,
The Niles Tool Works, Co., Hamilton, Ohio
SHAW, HERBERT G., Mechanic,
with Winchester Repeating Arms Co., New Haven, Conn.
SHELLEY, HERBERT V., Student,
Penn State College, State College, Pa.
STAFFORD, NORMAN L., JR.,
with Remington Typewriter Co., Syracuse, N. Y.
SWETTING, J. RODNEY, Student,
University of Wisconsin, Madison, Wis.
WALSH, WALTER V., Draftsman,
Henry Hope & Sons, New York
ZEIGER, NELSON A., Engrg. Dept.,
L. O. Koven & Bro., Jersey City, N. J.

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

BELL, JOHN E., Consulting Engineer, New York
BUCK, TURNEY E., Draftsman,
Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
LAIRD, WILBUR G.,
with Henry L. Doherty, New York

PROMOTION FROM ASSOCIATE-MEMBER

MOORE, EDWIN ADEE, Superintendent,
Gas Eng. Div., Fairbanks-Morse & Co., Beloit, Wis.

PROMOTION FROM JUNIOR

McCANN, WARREN E.,
with American Rolling Mill Co., Middleton, Ohio
McCORMACK, LEONARD J., Superintendent,
Schuylkill Silk Mills, Reading, Pa.
SCHMIDT, GEORGE G., Engr.,
Positive Differential System Co., New York
TUTTLE, WALTER I., Secretary,
Frank Mossberg Co., Attleboro, Mass.

SUMMARY

New applications	102
Applications for change of grading:	
Promotion from Associate	2
Promotion from Associate-Member	2
Promotion from Junior	4
Total	110

AVERAGE AGE AND POSITIONS OF APPLICANTS ON BALLOT CLOSING, MAY 22, 1916.

Average age of applicants:	
Members	40
Associates	36
Associate-Members	32
Juniors	25
Executives:	
President, Vice-President, Treasurer, Director, Member of Firm, General Manager	8
Professor, Associate-Professor, Instructor	
Gen'l Superintendent, Superintendent, Assistant Superintendent, Mechanical Superintendent	8
Consulting, Contracting and Constructing Engineers	4
Chief Engineer, Asst. Chief Engineer	5
Mechanical Engineer, Engineers, Assistant Engineers	25
Chief Draftsmen, Asst. Ch. Draftsmen, Designing Engineers, Estimators	8
Managers, Asst. Managers, Sales Managers, Sales Engineers	8
Other classifications	23

PERSONALS

THIS department is intended for items about members of the Society, their professional work and incidents concerning them which may be of interest to the membership in general. Items are solicited upon important engineering developments in which members have been associated, and also newspaper clippings or manuscripts of addresses delivered by members at meetings of any kind are desired. It is hoped that every member of the Society will furnish an interesting item occasionally for publication in The Journal.

APPOINTMENTS

C. W. LYON has become affiliated with the Lyon Concrete Products Company of Evanston, Ill., in the capacity of president.

CLARENCE W. VOGT has recently been appointed general manager of the National Foundry and Machine Company of Louisville, Ky.

ARTHUR D. LITTLE will have charge of the new Canadian Research Bureau which is being established by the Canadian Pacific Railway.

ARTHUR N. BLUM has become associated with Henry Disston and Sons, Philadelphia, Pa., in the capacity of technical adviser and chief engineer.

HENRY SOUTHER has been appointed, by the Secretary of War, consulting engineer in the aeroplane division of the United States Signal Corps.

WILLIAM F. TRAUDT, eastern sales manager of the Taber Pump Company, Buffalo, N. Y., has been appointed vice-president and general manager of the company.

CORNELIUS T. MYERS, engineer of The Timken-David Brown Company of Detroit, Mich., manufacturers of worm gears for motor cars and general work, has been appointed manager of the company.

EARLE B. NORRIS has been appointed industrial commissioner of the Association of Commerce, St. Paul, Minn. He was until recently associate professor of mechanical engineering at the University of Wisconsin, Madison, Wis.

SAMUEL M. VAUCLAIN has been elected a director of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. He is vice-president of the Baldwin Locomotive Works and a director in a number of companies.

BERTRAM G. WELCHANS has been appointed general superintendent of Stanley G. Flagg and Company, Pottstown, Pa. His former position with the company was that of mechanical engineer, in charge of manufacturing and machine design.

F. L. R. FRANCISCO, consulting engineer, New York, has been named by Mayor Thompson of Chicago as the city's representative on the Board of Supervising Engineers of the Railway Terminals Commission. Mr. Francisco succeeds Mr. Bemis.

HENRY M. LANE has been retained as consulting engineer of Leyshon and Lane, Inc., which has recently been organized to take over the oven and special foundry equipment business which has grown out of Mr. Lane's foundry research work. The H. M. Lane Company will continue as a consulting organization under the personal charge of Mr. Lane.

CHARLES E. BURGOON has been appointed assistant to the general superintendent of the Sandusky Portland Cement Company, Cleveland, O., and is making special investigation of kiln temperature relative to the output and cost of clinkers. He is also investigating economies in general, in connection with the design and operation of the company's plants.

At a meeting of the board of directors of the Yale and Towne Manufacturing Company held on April 27, JOSEPH A. HORNE, one of the directors, was elected to the position of second vice-president, retaining also his present position and title of general superintendent. Mr. Horne, who has been over 24 years in the company's service, has the entire management of the works at Stamford, Conn., and of all manufacturing operations of the company, including those of its Canadian plant at St. Catharines, Ont.

ANNOUNCEMENTS

SIDNEY A. REEVE has opened a consulting engineering office at 120 Broadway, New York.

FORD W. HARRIS announces the formation of the firm of Graham and Harris, patent attorneys, with offices in the Higgins Building, Los Angeles, Cal.

A. L. RIKER, vice-president and chief engineer of the Locomobile Company of America, was elected a director of the National Automobile Chamber of Commerce.

ROBERT R. FISHER, factory clerk with the Albaugh-Dover Company, Chicago, Ill., has accepted the position of efficiency engineer with the Walden W. Shaw Livery Company of the same city.

At the final meeting of the season of the Engineering Society of Buffalo, the present officers were re-elected. They are: John Younger, president; W. A. James and Jesse G. Melendy, vice-presidents; W. J. Gamble, secretary, and W. M. Dollar, treasurer.

W. S. QUIGLEY announces the organization of the Quigley Furnace Specialties Company, New York, as successors to the Quigley Furnace and Foundry Company. Mr. Quigley is president of the new corporation which comprises two departments, the furnace specialties department and the engineering and contracting department.

HERBERT C. HALE, formerly district manager of the Ridgway Dynamo and Engine Company, Cleveland, O., has announced the incorporation of The Hale-Stephan Company, Cleveland, O., which will represent the Taylor Stoker, the Ridgway Dynamo and Engine Company, the Vulcan Soot Cleaner Company and the Engineer Company.

ROBERT A. CARLETON, for many years inspector of construction with the Edison Electric Illuminating Company of Boston, Mass., and Albert E. Mace, have resigned their positions with the company and have organized a construction company to be known as the Carleton-Mace Engineering Corporation and will specialize in central station and industrial power plant installation and electric transmission systems, with headquarters in Boston.

CHANGES OF POSITION

JOSEPH E. YOUNG has accepted a position in the maintenance engineer's office of the American Steel Foundries Company, Sharon, Pa.

WILLIAM A. ARMES, industrial and power plant engineer, has become identified with the Samuel M. Green Company of Springfield, Mass.

WILLIAM J. KENNEY, chief engineer of The Under-Feed Stoker Company, Chicago, Ill., has become associated with the Moloch Stoker Company of the same city as president.

MORRIS D. DOUGLAS, salesman with The Midvale Steel Company of Philadelphia, Pa., will become associated with the Han-Yeh-Ping Coal and Iron Company, Hanyang, China, after June 15.

JOHN H. MCNALLY has left the employ of the City of Philadelphia to accept the position of Philadelphia manager of the Huber Hand Stoker Company, Inc., of New York.

H. H. MAXFIELD, master mechanic of the Pennsylvania Railroad Company, Pittsburgh, Pa., is now superintendent of motive power of the company, with headquarters in Pittsburgh, Pa.

FRANKLIN W. GILMAN has accepted a position with the B. F. Sturtevant Company, Chicago, Ill. He was until recently assistant chief engineer of the Western Electric Company, New York.

MARTIN H. RAY, formerly connected with the Department of Public Safety of Philadelphia, Pa., as consulting engineer, has entered the employ of the Crocker-Wheeler Company, Ampere, N. J.

LEWIS L. MCLAREN, until recently connected with the Wisconsin Steel Company, South Chicago, Ill., as steam engineer, has accepted a position with the Illinois Steel Company, Gary, Ind.

F. DONALD FENHAGEN, assistant engineer with Henry Adams, consulting engineer of Baltimore, Md., has accepted a position with the Bennett Company, Frankford, Philadelphia, Pa., as designing engineer.

PHILIP G. HAINES, formerly in the employ of The Laidlaw-Dunn-Gordon Company, Cincinnati, O., has become associated with the engineering department of the Goodyear Tire and Rubber Company, Akron, O.

CRAIG ADAIR, until recently in the employ of The Baldt Steel Company of New Castle, Del., as mechanical engineer, has become associated with the Penn Marine and Ordnance Castings Company, Inc., Philadelphia, Pa.

JOHN F. MAHONEY has resigned his position as draftsman with the Telegraph Bureau of the New York Fire Department to accept a similar position with the motive power department of the Interborough Rapid Transit Company.

C. LESLIE BARNUM has resigned his position as mechanical engineer of J. B. King and Company, New Brighton, N. Y., to accept a position on the staff of John H. Williams, efficiency engineer of New York.

AXEL E. BERGGREN has become identified with the American Blower Company of Detroit, in the capacity of salesman. He was until recently in the employ of the Faultless Rubber Company, Ashland, O., as mechanical engineer.

ROBERT G. BENNETT has been appointed assistant master mechanic of the Cumberland Valley Railroad at Chambersburg, Pa. He was formerly inspector of the test department of the Pennsylvania Railroad, Altoona, Pa.

LOYD E. SHIRLEY has accepted the position of vice-president and general manager with the Garland Manufacturing Company, Des Plaines, Ill. He was formerly connected with the C. S. Bell Company of Hillsboro, O.

FRANK R. LAWATSCH has severed his connections with the Guerber Engineering Company of Bethlehem, Pa., as engineering draftsman, to accept the position of ordnance draftsman at the Sandy Hook Proving Ground.

BYRON F. STOWELL has resigned as superintendent and mechanical engineer of the Van Norman Machine Tool Company, Springfield, Mass., to become master mechanic of Barney and Berry, Inc., skate manufacturers of the same city.

T. CARLILE ULBRICHT, who has been connected with the Havana Electric Railway, Light and Power Company, in various capacities, for the past 2½ years, has resigned to become assistant to the president of the American Steel Company of Cuba.

CHARLES W. TUBBY has been appointed St. Paul sales manager of the Worthington Pump and Machinery Corporation, which has recently been reorganized. He was formerly district manager of the International Steam Pump Company, St. Paul, Minn.

FRED W. WATERMAN, chief engineer and acting manager of the Lorain, Ohio, plant of the National Tube Company, will hereafter be manager of the company's new tube plant to be constructed at Gary, Ind.

CHARLES E. NEWBOLD, consulting engineer of the Craignish Estate, Princes Town, B. W. I., has accepted the position of assistant field manager and mechanical engineer with Leaseholds, Ltd., of Trinidad, B. W. I., which is developing the oil fields in the island.

WILLIAM T. CLARK has become affiliated with the Traylor Engineering and Manufacturing Company of Allentown, Pa. He was formerly in the employ of the Automatic Machine Products Company, Brooklyn, N. Y., in the capacity of general manager.

D. T. MCLEOD, for the past 16 years connected with the United Coke and Gas Company, American Coke and Gas Company and the Otto Coking Company, has opened an office at 50 Pine Street, New York, as consulting engineer in by-product coke oven plants.

C. A. SWIGGETT has accepted a position with the Western States Portland Cement Company, Independence, Kan., in the capacity of superintendent. He was formerly connected with the Iola Portland Cement Company, Iola, Kan., as mechanical engineer and assistant superintendent.

ROBERT A. MCKEAN, for some years structural engineer for the Jones and Laughlin Steel Company, Pittsburgh, Pa., has resigned to accept a similar position with the Riter-Conley Manufacturing Company, now owned and operated by the McClintic-Marshall Company, Pittsburgh, Pa.

GRENVILLE A. HARRIS, after 16 years of continuous service with Takata and Company, New York, has resigned his position as chief engineer and has accepted a similar position with the American Steel Export Company of New York, having entire charge of its newly established engineering and machinery department.

AUTHORS OF PAPERS, ETC.

W. M. WELCH has contributed an article on Natural Gas Resources and Supplies to the May issue of the *Natural Gas Journal*.

C. E. KNOEPPEL has contributed an article entitled Industrial Lessons from Germany to the May issue of *The Engineering Magazine*.

C. F. HIRSHFELD is the author of an article on Cleaning Condenser Tubes which is published in the May 16 issue of *Power*.

CLIFTON W. WILDER is the author of Power for Urban Transportation, which appears in the May number of *The Engineering Magazine*.

A. A. POTTER is the author of an article entitled Producer Operation and Testing, which appears in the May 2 issue of *Power*.

FRED H. WAGNER, gas by-product lecturer at Johns Hopkins University, is the author of a book entitled Coal and Coke.

ARTHUR C. SCOTT's second article on Lubrication of Station and Industrial Machinery is published in the May 13 number of *Electrical World*.

H. L. GANTT has contributed an article on Engineering Schools and Industrial Methods, to the May number of *The Engineering Magazine*.

A. LEWIS JENKINS is the author of Empirical Formulas for the Proportions of Lathes which appears in the May 4 issue of *American Machinist*.

GEORGE L. FOWLER is the author of an article entitled Hydrostatic Tests of Corrugated Culverts, which appears in the May 13 issue of the *Electric Railway Journal*.

JOHN S. UNGER presented a paper on Rail Manufacture at the spring meeting of the American Iron and Steel Institute, held in New York City, May 26 and 27.

W. DEWITT VOSBURY is the author of a brief article on Small Sewage Pumping Station for Park Site which was published in the May 6 number of *Engineering Record*.

JOHN A. MATHEWS presented a paper on The Electric Furnace in Steel Manufacture at the May 26 and 27 meeting of the American Iron and Steel Institute, held in New York City.

DABNEY H. MAURY contributed an article entitled Huge Circular Reservoir in Dubuque Protects Congested-Value Business District, to the May 6 issue of *Engineering Record*.

EDWARD H. TENNEY is the author of a book recently published on Test Methods for Steam-Power Plants, a reference book for the use of power-station engineers, superintendents and chemists.

WM. L. D'OLIER presented an illustrated paper entitled The Progress and Development of the Art of Sewage Treatment at the May 25 meeting of the Engineers' Club of Trenton.

C. B. AUEL, director of standards, processes and materials at the Westinghouse Electric and Manufacturing Company, has contributed an article on Methods of Figuring Costs to the May issue of *The Electric Journal*.

HOWARD E. COFFIN, Chairman of the Committee on Industrial Preparedness of the Naval Consulting Board, has contributed an article on Organizing Industry for National Defense to the May issue of *The World's Work*.

NECROLOGY

CHARLES A. FRANCIS

Charles Albert Francis was born in Mansfield, Mass., July 19, 1866. He received his early education in the schools of Mansfield and served an apprenticeship with the Mansfield Watch Tool Company there. From 1884 until 1890 he was machinist, tool and model maker for L. L. Pollands of Worcester, Mass. In 1890 he was mechanician for the Department of Physics in Clark University in Worcester; he remained there until 1894 when he was chosen for the same position at the University of Chicago, which he held until 1899. Between 1899 and 1903 he was tool maker for the Veeder Manufacturing Co. at Hartford; special mechanician at the Yerkes Observatory, and foreman of the Meter Department of the Diamond Meter Co. in Peoria, Ill., and was also with the Pratt & Whitney Co. in Hartford. In 1903, he became Instructor and Master Mechanic at the Higher Technological School in Tokio, and in 1913 he accepted a position as foreman at the General Electric Co. of Pittsfield, Mass., but left in 1915 to go with the Remington Arms Co. of Bridgeport, Conn. He became a member of the Society in 1905. Mr. Francis died at his home in Bridgeport, January 14, 1916.

HOWARD D. HESS

Howard Drysdale Hess was born at Philadelphia, September 6, 1871. He received his education at the Central High School in Philadelphia and at Lehigh University, from which he graduated with the degree of mechanical engineer in June, 1896. Following his graduation he was appointed general manager with the Eastern Steel Company at Pottsville, which position he held for one year, resigning to accept a position in the faculty of Drexel Institute, where he served two years. During 1904 he served on the faculty of Kansas University at Lawrence, and from there went to Cornell as assistant professor of machine design. In 1910 he was made professor of machine design, which position he was holding at the time of his death. Professor Hess was a member of the Engineers' Club of Philadelphia, Sigmi Zi honorary fraternity, and the Town and Gown, University and Cosmopolitan Clubs of Ithaca. He became a member of this Society in 1903. He died in Buffalo on April 22.

JOHN EDSON SWEET

Professor John Edson Sweet died at his home in Syracuse on Monday, May 6, at the age of eighty-three. An appreciation of Professor Sweet is published elsewhere in this issue of The Journal, and the facts of his life are only briefly summarized here.

He was born in Pompey near Syracuse October 21, 1832. His only opportunity for schooling was in the district schools of that time. As a boy he worked on a farm, and later became a carpenter's apprentice. He was an architect and builder in the South for several years, but on the outbreak of the Civil War in 1861 he returned to the North. From this time until 1873 he was an inventor and mechanical draftsman; at the latter date he was appointed Director of Shops in Sibley College. In 1879 he left Cornell to establish the "Straight Line Engine Company" in Syracuse; he was president of this company from its establishment until his death.

Professor Sweet was one of the founders, and was the third president of the Society. In 1914 the John Fritz Medal was awarded to him "for his achievements in machine design, and for his pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine," and in the same year Syracuse University conferred upon him the honorary degree of Doctor of Engineering.

Thus he received honors in recognition of his great ability as an engineer. But his great life work consisted in his influence over men to cause them to think straight and to live honorably. All who were his students at Cornell or elsewhere—for he was a teacher all his life—have always felt for him the highest respect and deepest affection; and his death brings to them all a sense of personal loss. The world can so ill afford to lose those rare men of sane brain, sound judgment and big heart who love to serve their fellow men.

MAX M. SUPPES

Max M. Suppes was born at Johnstown, Pa., February 18, 1856. He received his education in the common schools at Johnstown, and learned the machinist's trade in a machine shop there.

He went to Troy, N. Y., in 1879 as master mechanic for the Rensselaer Iron & Steel Works (later the Troy Iron & Steel Works). Here he was associated with Capt. Robert W. Hunt, and helped develop the first automatic rail mill for rolling Tee rails. From Troy he went to Braddock in December, 1887, as assistant master mechanic of the Edgar-Thomson Works. He only remained at Braddock about a month, returning to Johnstown on February 1, 1888, to be master mechanic of the Johnson Steel Street Rail Company, which was being built by Messrs. A. J. Moxham and Tom L. Johnson. In the fall of the same year he became manager of the rolling mill department of the plant. Here he assisted very largely in the development of the method of rolling girder rails.

Early in 1894 when Messrs. Moxham and Johnson decided to build a Steel Plant at Lorain, Ohio, and move the girder rail mill at Johnstown to Lorain, he was appointed general manager of the new plant and put in charge of the construction of it. Active construction operations began at Lorain in July, 1894, and the first heat of steel was blown April 1, 1895, and the first steel rolled in the blooming mill a few weeks later; in other words, the plant was built in a period of ten months. This Lorain Plant was first known as the Johnson Company, then as the Lorain Steel Company; was later taken over by the Federal Steel Company; it is now The National Tube Company of Ohio.

Through all these changes and the continued expansion of the plant, Mr. Suppes continued to be the manager until the date of his death, March 27, 1916.

He was a man of very marked engineering ability. He was of an inventive turn of mind, evidence of which is amply given in the large number of patents issued to him, many of which are in use in various steel mills. In 1883 he installed the first tables in front of rolls on a rolling mill. He developed the first arrangement for rolling steel out of heating furnaces. Other rail mill and blast furnace improvements originated by him are well known, such as his weighing device for rolling mills, leading spindle and coupling for rolling mills, roll adjusting mechanism for rolling mills, stock distributing and collecting apparatus for blast furnaces, etc. His expansion joint for engines is used on a great many reversing engines. One of his later developments was a stock handling and storage arrangement for open hearth furnace plants.

He was a member of the Iron & Steel Institute (British), the American Iron & Steel Institute, also of the Masonic Order and Royal Arcanum. He became a member of the Society in 1890.

DARWIN ALMY

Darwin Almy was born in Tiverton, R. I., on February 28, 1848, and died in Providence on March 9, 1916. He attended the local schools in Tiverton until about sixteen years of age and then took up work on his father's farm until 1868. Afterwards, he became interested in menhaden fishing and was master of one of the first fishing steamers out of Tiverton.

In 1874, he went to Providence and formed a partnership for the manufacture of jewelry, which was abandoned, however, about two years later. After this, he returned to the fishing business.

In 1878, he entered the employ of the Herreshoff Manufacturing Co. at Bristol, R. I., and had charge of the boiler department and also the advantage of taking part in numerous trial trips of fast steam yachts. During the first part of this time, the Government conducted there a series of experiments under Admiral Zellar and Admiral Isherwood on engines and boilers and through this association became very much interested in steam engineering.

In 1890, he took out his first patents on the boiler which bears his name, and organized the Almy Water-Tube Boiler Co. of which he was the head until his death.

He was a member of the American Society of Naval Engineers, Society of Naval Architects and Marine Engineers, Providence Association of Mechanical Engineers, Chamber of Commerce of Providence, Central Club of Providence, Bristol Yacht Club and Rhode Island Yacht Club. He became a member of the Society in 1893.

SOCIETY MEETINGS

IT is of the highest importance in the development of the monthly meetings of the Society, both of the Sections and of the Student Branches, that comprehensive reports of these meetings be published in The Journal regularly. Secretaries of the sections and student branches are urged to make every effort to get the complete reports of their meetings to this office as quickly as possible after the meetings are held, and also where possible, copies of the papers presented should be sent in; if desired, the copy of the paper will be returned after examination. The reports of meetings in order to appear in the next issue of The Journal must be received in this office before the 18th of the month.

LOS ANGELES, MARCH 28

On March 28, the Los Angeles Section of the Society had a very successful meeting at which Prof. W. H. Clapp delivered his paper on Motor Trucks and Their Use in Southern California. This paper was ably discussed by Carl Breer, F. H. Coble and others.

MINNESOTA, APRIL 14

On April 14, a joint meeting of the Minnesota Section was held with the American Institute of Electrical Engineers and the American Society of Civil Engineers at the University of Minnesota. A. L. Rohrer, electrical superintendent of the Schenectady Works of the General Electric Company, gave an illustrated talk on the Electrification of the Butte, Anaconda & Pacific Railway and George H. Hill, assistant engineer of the Railway Traffic Department of the General Electric Company also spoke on the Electrification of the Chicago, Milwaukee & St. Paul Railroad. M. E. Simpson, mechanical superintendent of the Minneapolis Steel Machinery Company, spoke on the Manufacture of High Explosive Projectiles, and Edwin Rollman, Captain, Cadet Corps of the University of Minnesota, on the Method of Firing Projectiles. Both of these talks were illustrated.

CINCINNATI, APRIL 21

Members of the Cincinnati Section of the Society were the guests of the Engineers' Club of Cincinnati at the regular meeting on April 21. The paper of the evening was read by Fred W. Hinkle on Prehistoric Engineering in Southwestern Ohio. A brief abstract of Mr. Hinkle's remarks appears below:

The southwest quarter of Ohio is interesting to students of archaeology because of the great number of prehistoric mounds and earth-works that it contains. Especially interesting are the great works on the hill tops which from their construction and location appear to be fortifications, and the so-called "geometrical" works which usually occupy lower lands on the second and third river terraces.

Unfortunately, they were constructed in many instances on the present sites of our cities, or rich farm lands which have now been long under cultivation, so that many of these great works are either entirely or in a large part destroyed. It is to be regretted that our pioneers did not take steps to preserve more of them for posterity.

Some of the most extraordinary works were constructed upon the present sites of Newark, Marietta, and Portsmouth, and some portions of these have been preserved in public parks. While the works on the site of Cincinnati were not as intricate or numerous as these, they were of considerable extent and represented circles, ovals, parallel walls and simple mounds in one of which, that at Mound Street, was found the famous Cincinnati Tablet.

The geometrical works may be roughly described as combinations of great earth circles, ovals, squares, octagons, conical mounds and parallel walls. Some or all of these occur in combination in the same works covering large areas. Works of this character in the vicinity of Cincinnati are the Turner Group just east of Newton, Ohio, and the group lying east of and on the watertower hill at Milford. Both of these are in part destroyed by the encroachments of civilization.

The articles found in the depositories of the mounds of the Turner Group typify the highest culture of prehistoric peoples in Ohio. Among the most interesting are terra-cotta figurines of men and women; ornaments of copper or meteoric iron, sometimes covered with gold or silver; painted effigies of animals cut out of mica; stone bowls carved in the shape of animals and thousands of river pearls in the shape of beads. The Turner Group people were evidently of the high culture of those who erected the Tremper Mound near Portsmouth, recently opened by Mr. Mills of the Ohio Archaeology Society, whose illustrated monograph on the excavation of this mound is extremely interesting and valuable.

Of the hill top fortifications, there is a small one at the mouth of the Big Miami, which is splendidly preserved, and should be made a public park. The greatest of all is Fort Ancient which is owned and preserved by the State and is a lasting monument to its builders. It should be visited by all who are interested in seeing what extraordinary labors could be accomplished by people whose only implements were of stone, bone and wood.

The most mysterious earth-work in the State is the Serpent Mound in Adams County, and is preserved by the State in a public park.

By whom and when these earth-works were erected must ever remain a mystery. No evidence of a written language has been discovered and there is little if anything in the works themselves or the articles found in them to point to their age. Some of them may have been erected by the ancestors of historic Indian tribes but this is mere theorizing. Whoever the builders of the "geometrical works" and the hill top fortifications were, we must admit they possessed extraordinary industry and a considerable degree of engineering skill.

PHILADELPHIA, APRIL 23

A meeting of the Philadelphia Section of the Society was held on April 23, and was preceded by an informal dinner. After the dinner, Professor Fernald, chairman of the Philadelphia Section introduced Dr. D. S. Jacobus, President of the Society, who addressed the members on Society Affairs.

Dr. Jacobus illustrated his talk with numerous lantern slides showing how the funds of the Society are expended. He showed tables, extending over a period of years which gave the cost per member of the various items and called attention to the fact that the expenditures have always been kept less than the income and that the mortgage on property in New York has been nearly paid off. The amount of money devoted to local sections was shown and also a comparison of the costs of the various items for the mechanical engineers with the corresponding costs for the electrical, civil and mining engineers. There were also numerous photographs of the Engineering Societies Building in New York.

Dr. Jacobus invited discussion and suggestions from all present and there was a general discussion by Messrs. Fernald, Henderson, Taylor, Hess, Yarnall, Carter, Sinclair, Parker, Jackson, Cadwallader and others present. Two points were brought out in the discussion; *first*, the desirability of providing means to make members feel at home when visiting headquarters in New York and *second*, some ways of overcoming the disadvantages of publishing matters in both The Journal and in the Transactions. Mr. Hess moved that The Journal be published more frequently if possible and if sufficient material be available, that it be published weekly. The motion was carried.

BUFFALO, APRIL 26

A meeting of the Buffalo Engineering Society was held on April 26 at the Hotel Statler. The subject of the meeting was National Preparedness and the speakers were Elmer A. Sperry, Mem. Am. Soc. M. E., and of the Naval Consulting Board and Calvin W. Rice, Secretary of the Society.

Mr. Sperry, who is the inventor of the Gyroscopic Stabilizer, spoke on the work of the Naval Consulting Board. He paid a great deal of credit to Howard E. Coffin of the Board who is spending time and money furthering the interests of the nation in a preparedness way. He has established various bureaus through which the resources of the country are being estimated and arranged in order for a time when they will be needed. In the interests of emergency transportation for instance, he has conferred not only with the heads of railways, but with other interests which might be useful. Even automobiles are listed and owners of pleasure vehicles are taken account of after the fashion of the efficiency methods of the German Government. Mr. Sperry said that the spirit of the naval officers towards the Naval Consulting Board is cordial, though at first there was a little hostility apparent.

Mr. Sperry is chairman of the torpedo committee of the Board and he told of the development of that instrument of warfare from the time when it would go only a few hundred feet and waver to the perfected device of today which goes absolutely straight as far as it goes at all and is effective as far as several thousand feet.

The subject of Mr. Rice's talk was Industrial Mobilization. He said that we have brought the army and navy together but it is up to the people now to see that Congress affords the country sufficient funds to put it in a state of preparedness. He told of a plan to have munition orders placed in all factories doing an annual business of $40,000 or more, these to be just small orders to develop ability to produce in time of need. These industries are to be inventoried between May 1 and May 20 and in order that the members of the engineering societies will meet with no opposition, advertisements are to be used during that time to explain the situation and aim to all the members of the Society.

We are unprepared in this respect at present because we have accepted orders for making rifles and have been making them for export for more than a year and not one rifle has as yet been shipped. They have been rejected for one reason or another. One firm has on its property, 5000 rejected rifles. The number of rifles necessary has been shown during the European War, where it has taken four rifles to one soldier—one in use, one away for repairs, one overheated and the fourth out of order in some way or other.

One other thing is necessary. The engineers who have certain qualifications should offer their services for the duties with which they are best acquainted and should not be drafted as privates for there are those who have no special training who can go as privates.

In answer to a request from Mr. Rice, Mr. Sperry told of the method of choosing cadets for the military and naval academies. He said that the machinery of war and the method of operation are hard to understand and that a man must have a mechanical sense. Mr. Sperry said that he would not appoint a cadet without first ascertaining what he did between the ages of ten and seventeen. If he spent his time reading books or playing baseball, he would be no good so far as appointment would go but if he had always been trying to build a machine, if he had clocks about on the floor, he would be a likely candidate. Cadets are to be appointed this year in larger numbers than heretofore.

Civil and mining engineers can be of greater service in the army than mechanical and electrical engineers, who are needed in the navy. There are some wonderful boats in the Philadelphia Navy Yard which are out of commission because we have not the officers and the skilled men to handle them; if we had skilled mechanical and electrical engineers a few officers could handle these vessels.

PROVIDENCE, MAY 3

The first annual dinner of the Providence Engineering Society, recently reorganized from the Providence Association of Mechanical Engineers to include a wider membership, was held on May 3, at which Henry A. Wise Wood spoke on Preparedness. There were other speeches emphasizing the value of greater coöperation among the various branches of the engineering profession.

Those who spoke in addition to Mr. Wood, were President Faunce of Brown University, Mayor Gainer of Providence, Arthur H. Annan, president of the Providence Engineering Society, Luther D. Burlingame of the Brown & Sharpe Company, Calvin W. Rice, Secretary of the Society, Prof. Hardy Cross and Dr. Charles F. Scott, who is the head of the Sheffield Scientific School at Yale University. Frank B. Gilbreth acted as toastmaster.

Mr. Wood told his audience that as a body of men accustomed to close thinking they could appreciate the danger to which the country is being put because so many people are thinking about the question of preparedness with their hearts instead of their heads. From his observation, as a former member of the Naval Consulting Board, he criticized American political representatives for not listening to expert opinion. He cited a case of an admiral who tried to get two draftsmen at $30 per week in order to put certain submarines into condition; his recommendations were cut, while large sums were voted for post offices for which there was no need.

A novel touch to the proceedings was provided by the committee on arrangements. A large American flag was played on with a calcium light as Mr. Wood began to speak. As the light was flashed on, everyone present rose and sang The Star Spangled Banner.

President Faunce congratulated the engineers on the newly organized society which has for its purpose not only the bringing together of all branches of the profession but also the close connection of engineering with the good of the community,—the making easier of civic service on the part of the engineers.

Mayor Gainer spoke briefly in the same vein, telling the society that in his official capacity he had been made to realize how intimate the connection is between municipal progress and the work of the engineer.

Calvin W. Rice, Secretary of the Society, sketched the growth of the idea of coöperation among engineers and gave as instances of the new phases of their service, the proposed auxiliary corps of civilian engineers and military training in all technical schools, and two amendments to the Army bill now before Congress which were secured through the efforts of The American Society of Mechanical Engineers.

The Committee on Arrangements was composed of J. Ansel Brooks, chairman; Arthur H. Annan, Milton H. Brondson, John R. Freeman, John A. Gledhill, Russell C. Lowell, William H. Paine and Alfred H. Whatley.

LOS ANGELES, MAY 4

The Los Angeles Section of the Society has lately adopted the policy of holding a luncheon meeting each week and having some member or non-member talk for ten minutes at each meeting. The meetings have so far been very successful.

On May 4 the subject discussed at the luncheon meeting was that of Industrial Preparedness. W. W. Smith, chairman of the Section presided and made a brief address in which he called attention to the fact that the European War has taught us that thorough organization is far more efficient in obtaining results than great masses of men at the front, and that for this reason, the organizing of the engineers of America for defense has become a movement of great importance.

He outlined the general plan of this movement stating that it includes the five technical societies of engineers and read a letter from President Wilson in which he gave hearty approval to the general plans.

A letter from Howard E. Coffin, chairman of the Committee on Production, Organization, Manufacture and Standardization of the Naval Consulting Board was read. He expressed the urgency of the work proposed by requesting that quick action be taken in appointment of the necessary field men etc., and that the telegraph wires be used as a matter of saving valuable time.

The plan provides for the making of a thorough inventory of American industries for the first time in the nation's history in order to determine just what each unit may be able to do in the way of manufacturing munitions of war; then the placing of this vast power behind the army and navy through the placing of government orders with factories in each section of the entire country so that they may have the drill of actual experience. There is also included the organization of labor, so that it may be definitely known just what available labor resources are on hand that they may be withheld from enlistment in time of general call, to render even more valuable service in the manufacturing of the necessary supplies.

The program includes the placing of orders in time of peace by the Government for an annual minimum production of munitions of war to be paid for at reasonable but not an excessive basis of profit and to spread out these orders over the entire United States so that no one territory will have a monopoly thereof.

California has five State directors in this movement each representing one of the divisions of engineering. C. W. Merrill of San Francisco is the chairman for the mechanical engineers.

NEW YORK, MAY 9

The regular meeting of the New York Section of the Society was held on May 9, at which was presented a paper on Report Upon Efficiency Tests of a 30,000 kw. Cross-Compound Steam Turbine by Henry G. Stott and W. S. Finlay, Jr. The paper with the discussion which followed its presentation is published elsewhere in this issue.

At this meeting, a committee was chosen to prepare a constitution and by-laws for the government of the New York Section. The members of this committee are: Fred R. Low, chairman; Robert T. Kent, Frederick A. Scheffler, James A. Kinkead and H. G. Stott.

BIRMINGHAM, MAY 12

A meeting of the Birmingham Section of the Society was held on May 12. The officers of the Section who have been serving this past year were reëlected for the coming year: R. E. Brakeman, chairman; C. B. Davis, vice-chairman; Paul Wright, secretary and treasurer.

A general discussion took place concerning recent letters

that have been received from the State Committee of the Naval Consulting Board. Following this, the members discussed letters which had been received from Thomas E. Durban, chairman of the Uniform Boiler Law Society. It was decided that the Section should do what it could to aid in the securing of the adoption of the Boiler Code in the state of Alabama and the following committee was appointed to keep in touch with the matter and to report from time to time its progress to the Section: Richard Faull, *chairman;* H. A. Moon, W. P. Caine, F. G. Cutler.

ST. LOUIS, MAY 20

A dinner was held by the St. Louis Section of the Society on May 20, at the Missouri Athletic Club, at which fifty-one members and guests were present. W. A. Layman, president of the Wagner Electric Company was the speaker and his subject was Mobilization of American Industries for National Protection.

Mr. Layman's talk went into the general subject of our lack of industrial preparedness, and brought out very forcibly the fact that while we might be able to get together one or two million men in six months, it would easily be two years before we were able to maintain a force of even one million in the field. He cited many instances of failure to even start delivery of munitions by American concerns within a year of the time promised, due to the lack of men, material, tools and gages, the last lack being, perhaps, the most serious of all.

He pointed out the fallacy of the argument that many manufacturers were anxious for preparedness, because of the supposedly huge profits to be made. On the basis of his figures, excepting perhaps the powder manufacturers, most of those firms who have gone into the munitions proposition have done so at a loss, particularly those holding contracts made when times were dull; now they have to face a rising market both in prices of material and labor.

He brought out strongly the industrial preparedness of Germany for the present conflict, and the almost criminal action on the part of the British labor organizations in their unwillingness to sacrifice anything for their country, in order to increase the output of needed munitions.

After the close of Mr. Layman's address, there were brief talks by others on the same subject, and Professor Ohle and Mr. Day told of the New Orleans meeting of the Society on April 11-14.

Following these talks, an election of officers for the ensuing year was held. Following the established custom, the two last Chairmen of the Section, Edward Flad and F. E. Bausch, became members of the new Committee. The new members elected were L. A. Day, of the Saint Louis Water Works; L. Gustafson, superintendent David Rankin School of Mech. Trades; H. R. Setz, chief engineer of the Fulton Iron Works.

PHILADELPHIA, MAY 23

The last meeting for the season of the Section in Philadelphia was held Tuesday evening, May 23, at the Engineers' Club. Professor R. H. Fernald presided.

The paper of the evening was by Lieut-Commander H. C. Dinger, U.S.N., on Efficiency of Propulsive Machinery and Late Developments in Naval Engineering. Besides reviewing in an able manner the progress of engineering in the Navy, the speaker made an appeal to the engineering profession to coöperate in all ways to better place our country in the state of preparedness.

In connection with this timely request, the Secretary of the Society, Calvin W. Rice, spoke with special earnestness and promised the fullest coöperation in fact and in the spirit with which this request on the part of representatives of the Navy was made.

Following the paper the Chairman-elect of the Section, E. B. Carter, who also has the honor of being President-elect of the Engineers' Club for the ensuing year, was presented.

The obligation is, therefore, that our Section in Philadelphia, through its Chairman, shall make itself especially useful in assisting to get the entire engineering profession in Philadelphia and vicinity to center around the Engineers' Club.

As an earnest of this coöperative spirit, prior to the meeting Professor R. H. Fernald, the retiring Chairman of the Section, gave a dinner at the University Club, to which invitations had been extended to the officers of all the local technical organizations, including the President and Secretary of The Franklin Institute, the President-elect of the Engineers' Club, the Chairman-elect of the Section of the Am.Soc.M.E., the Chairmen of the Sections of the American Society of Heating and Ventilating Engineers, of the Illuminating Engineering Society, of the Society of Automobile Engineers, of the Association of Members of the American Society of Civil Engineers, of the American Institute of Electrical Engineers, and the Technology Club of the Massachusetts Institute of Technology. With the exception of the Technology Club and The Franklin Institute, all of the above societies were represented, together with the full committee of the Am.Soc.M.E. Section. The guests were as follows: Messrs. E. B. Carter, J. D. Cassell, G. S. Crampton, H. C. Dinger, H. E. Ehlers, E. S. Foljambe, J. E. Gibson, W. R. Jones, Calvin W. Rice, J. A. Steinmetz, E. B. Temple, and J. H. Tracy. In honor of the speaker of the evening, Rear Admiral Parks, and Commander S. E. Moses were also invited. The occasion was very enjoyable and presaged a successful forthcoming season. The spirit of coöperation was manifest throughout the evening.

BOSTON, MAY 23

The last meeting of the season of the Boston Section of the Society took place on May 23, at the Engineers Club Hall. E. G. Bailey, president of the Bailey Meter Co. of Boston, presented the subject of Measurement of Steam Flow to Determine Boiler Output or Prime Mover Capacity and the Measurement of the Condition of Fuel Beds in Order to Control the Efficiency of Boilers. Lantern slides were used to illustrate the points brought out by Mr. Bailey, who is an authority on these most important subjects.

In the discussion which followed the paper, Walter S. Burke, Supt. of Bldgs. & Grounds at Harvard University, spoke of the meters used to measure steam flow and also of those used to measure the condensation in connection with the purchase of steam from the Boston Elevated Railway by Harvard University, which purchase amounts to some $40,000 per year. The net B.t.u. are computed and paid for on the basis of heat supply. Mr. Burke mentioned particularly the CO_2 method of calibrating meters as being very valuable, affording a convenient and close method of determining just what results the flow meter is giving. Where meters have been placed in series, they have been found to register alike, one serving as a check on the other.

With the Bailey-Weir meter, results within a small fraction of 1 per cent of the actual weighed water were registered. Mr. Burke considered Mr. Bailey's method of handling the fire by means of charts for the use of firemen very important.

A. B. Duncan of the Harmony Mills stated that they used a number of steam meters and believed that they saved at least

25 per cent due to the use of these meters to show the requirements of the various departments.

F. S. Uhling spoke regarding the CO_2 recorders and John A. Stevens of Lowell gave experiences in the use of meters especially with regard to connecting several sources with a single meter for measurement with suitable valves to cut off different sections of the plant. He also mentioned a case where an expensive meter was put in to be used only once a month to test steam consumption of turbines.

The subject was also discussed by Mr. Dodge, head of the Meter Dept. of the General Electric Co., Geo. I. Rockwood, Chas. T. Main and Mr. Delano of the Edison Co.

STUDENT BRANCHES

Members of student branches are requested to notify the Secretary of any change in address as promptly as possible, in order to facilitate delivery of The Journal.

BUCKNELL UNIVERSITY

On May 1, 1916, the regular meeting of the Bucknell University Student Branch of the Society was held, at which E. V. Anderson gave a talk on The Use and Application of the Automatic Double Cushioned Triple-Acting and Non-Return-Valves. Mr. Anderson explained how they insure safety both to the plant in which they are installed and the men employed by automatically operating in case of accident due to the bursting of boiler tubes or other ruptures either in the boiler main steam line or branches. Boilers equipped with such valves, Mr. Anderson said, will operate at a uniform pressure and at an increased efficiency, and are a necessary safety device in a plant or power station.

After the talk Messrs. Hartman, James and Hay gave short discussions on the subject of the valves as they found them in plants and stations where they have been employed.

COLORADO AGRICULTURAL COLLEGE

The Colorado Agricultural College Student Branch held a meeting on April 24, at which Professor Cammack gave a talk on a steam pipe covering test, which he conducted as a thesis for graduation from Iowa State College. This test was made to determine the efficiency of various thicknesses of magnesia pipe covering on different sizes of steam pipes. Tests were made to find the saving of heat with both single and double coverings. The test was made with a special system of piping for supplying the steam to the test pipe and for drawing off the condensed water from the test pipe.

There were four separate sizes of test pipe used, varying from one inch to seven inch pipes. Two different thicknesses of covering were used for each test pipe, and records were taken every two minutes during a run of two or three hours. The condensed water was weighed at regular intervals throughout the test and the efficiency was determined from the comparison of covered with bare pipes. The efficiency was first calculated in percentage, and the actual saving in money was also calculated for both coverings for all sizes of pipes used in the test. The tests showed a greater saving made with the larger sizes of pipes, although a very great saving was made by covering any or all of the pipes.

KANSAS STATE AGRICULTURAL COLLEGE

A meeting of the Kansas State Agricultural College Student Branch held on April 27 was a joint meeting with the A.I. E.E. members. The papers which were presented were prepared by the students in electrical enginering who had visited the various power plants in Kansas City during the inspection trip on April 13 and 14. The papers were discussed by the students in mechanical engineering.

LEHIGH UNIVERSITY

A meeting of the Student Branch of Lehigh University was held on April 6. The first speaker was Lieut. E. P. Finney of the United States Navy, who is at present stationed at the Bethlehem Steel Works to oversee the guns and armor plate being made for the Government. Mr. Finney spoke on The Organization of the Battleship. He said that as the battleship is the most important unit in the fleet, its organization represents one of the highest types of scientific management. The ruling officer is the captain, who has supreme authority. To carry out his orders, there is next the executive officer, who really acts as general manager of the ship. The rest of the men on board are grouped under various divisions: the navigation department, ordnance and gunnery department, medical and supply department, and the engineering department.

All the enlisted men are divided into two divisions: the deck force, whose duty is to take charge of the fighting, and the engineering force, who have charge of the running of the ship. The deck force is separated into divisions, each of which has charge of a certain turret or number of guns. Every one of these divisions has its own commanding officer, and he is responsible for everything done by the turret which he is commanding.

The most valuable and instructive duty of the ship is target practice. Problems of actual battle are always used, and maneuvering is done the same as in actual fighting. The targets are usually at a distance of 20,000 yards from the ship. They are set upright on rafts, and are 50 ft. wide and 30 ft. high.

In target practice, organization shows up in the highest degree. The crew of each gun must be experts and the men who control the turning of the turrets must be absolutely sure in their work. In battle all the turrets must be fired together, which requires absolute team work.

As to the duties of the various departments, the ordnance and gunnery department takes care of the battery and ammunition, and the ordnance officer has charge of target practices. The duty of the navigation department is to look after the directing of the ship in its course. As there are about 1200 men on board each ship to be fed, looked after, and clothed by the medical and supply department, the duties of these men are not very light. Lastly, the engineering department includes all the men who run the boilers, the engines, and the rest of the machinery of the battleship.

Another part of ship organization is that it must be ready for shore work. The battleships at Vera Cruz were practically useless because landing could not be made easily. For shore work, a landing crew is necessary and a reserve crew to man the guns on board ship.

In the landing crew there is one battalion consisting of one company of artillery and the rest infantry. At a given signal every man knows where to go, and in the short time of half an hour everything is made ready for landing.

A. V. Bodine, M.E., '15, who is now connected with the Winchester Repeating Arms Co., New Haven, Conn., was the second speaker. His subject was Scientific Management. He said that industrial engineering and industrial management are steadily drawing closer together and rapidly becoming complementary elements in the professional work of a great number of mechanical engineers. For several years there has been industrial activity in the United States, and the great conflict now waging in Europe, which is taxing American factories to their utmost capacity, has brought attention to the need of Scientific Management in our shops.

Many people wonder what Scientific Management really is. Morris L. Cooke has said, "Scientific management is not something that can be bought in a box. It is not something in the nature of a drug that one takes and feels better. It is not a card index. It is dependent upon no single mechanism, nor is it a combination of any number of mechanisms. It is not a system of keeping costs, nor is it a method of paying wages." What then is this thing that has caused so much discussion in the industrial world? It is the search all along the line that reveals conditions which do not conform to definite law and principle; and having found them, makes them conform to what is right.

Before starting to make any changes in the organization of a company, there are certain matters that should be carefully considered: *First,* the importance of choosing the general type of management best suited to the particular case. *Second,* that in all cases money must be spent, and in many cases a great deal of money, before the changes are completed which result in lowering cost. *Third,* that it takes time to reach any results worth aiming at. *Fourth,* the importance of making changes in their proper order, and that unless the right steps are taken great danger from deterioration in the quality of the output and from serious troubles with the workmen, often resulting in strikes.

Scientific management provides: *First,* a careful analysis to determine, before work is undertaken, exactly what is to be accomplished; *second,* the determination of the best way to accomplish the work in the quickest time at the lowest cost; *third,* the employment of the best machines, best facilities, and the best men available to carry out the work in the best way, as previously determined; *fourth,* cordial coöperation between employers and employees in order that both may put forth the best efforts to secure low production costs; and, lastly, an accurate record of the cost of the work in such detail that the various elements of cost may be quickly determined.

A meeting of the Branch was held on May 11, at which C. H. Schuttler spoke on Stresses in a Conical Tank. He presented the theory of the stresses and the results derived, basing his theory on a tank which he himself designed for the Bethlehem Steel Company. Following the lecture, the students were shown a tank made of rubberized cloth, which sustained the theory and the results which Mr. Schuttler had derived.

At this meeting the following officers were chosen for the coming year: G. M. Levy, president; F. M. Porter, secretary; G. T. Custer, treasurer, and G. K. Bishop, librarian.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The Student Branch of the Massachusetts Institute of Technology held their annual banquet and final meeting of the year on April 25 at the Engineers Club. Reports of the officers, showing what the Branch had done during the past year, were read and the results of the election of officers for the coming year were given out. Those chosen for office were as follows: W. L. Pryor, chairman; A. P. Dunham, vice-chairman; E. W. Rounds, secretary; S. Sewall, treasurer, and R. W. Logan, F. A. Stearns and A. E. Windle, the governing board.

Prof. E. F. Miller, Mem. Am. Soc. M.E. and honorary member of the Branch, gave a short talk outlining the advantages of membership in The American Society of Mechanical Engineers and advised all members of the local branch to become members of the Am. Soc. M.E. as soon as possible.

Prof. R. B. Wilson spoke on Success. He emphasized the fact that a man need not be a genius to succeed and that opportunity and the ability to make use of it is as much a factor in success as genius. F. W. Hobbs, '89, president of the Arlington Mills, told of the present opportunities for the technically trained man and also why a man should be a member of the Am. Soc. M.E.

POLYTECHNIC INSTITUTE OF BROOKLYN

The Student Branch of the Polytechnic Institute of Brooklyn held a joint meeting with the Student Branch of the A.I.E.E., the Chemical Society and the Alumni Association, which was in the form of an annual dinner, on May 1. The transcontinental telephone was the big feature at the dinner. Maj. Gen. Leonard Wood and Lieut. Commander Jessop were both present. A receiver was at every plate and the diners could hear talk with Pittsburgh, Chicago, San Francisco and the intermediate cities on the line. The University of California was holding a meeting the same night, and members of the faculties of both institutions held a conversation. General Wood and Lieutenant Jessop addressed the University of California students on Preparedness, and their remarks were received with great enthusiasm. A duet was sung over the phone, a soprano singing in Berkeley, California, and a baritone singing in New York.

Mr. Theradi and Mr. Schmidt of the New York Telephone Company explained the workings of the line and its development. The guests included Dr. D. S. Jacobus, President of the Society, J. J. Carty, president of the A.I.E.E., and Dr. Nichols of the Nichols Copper Company.

RENSSELAER POLYTECHNIC INSTITUTE

The Student Branch of the Rensselaer Polytechnic Institute held a meeting on May 2, at which H. deB. Parsons, emeritus professor of practical engineering and a manager of the Am. Soc. M.E., gave a very interesting illustrated lecture on Perpetual Motion and other Engineering Fallacies. Mr. Parsons said that most all mechanical fallacies were founded upon the principles of magnetism, capillary attraction or the laws of gravitation. He showed a number of slides of mechanical devices which had been built, and pointed out how each was designed to make use of one or other of the above principles. These devices, he said, purposed efficiencies greater than unity, which, of course, is obviously impossible.

Mr. Parsons then spoke of the use of liquid air as a source of power and of bisulphide vapor as a medium to replace steam for the operation of engines. He then gave a brief description, accompanied with slides, of the various attempts which had been made to propel boats by a jet of water. One of the first boats which was designed to utilize this principle was built by Dr. Jackson. It was 110 ft. long and was expected to reach a speed of 30 knots an hour. Upon test, however, this boat failed to give the expected speed, and was only able to attain a speed of 5 or 6 knots an hour. In 1896 the Bazin roller boat was constructed in France. This boat was built with large lenticular wheels and designed to roll on the water at about 22 knots an hour. Like the first mentioned boat, however, this also failed to give the expected speed, and only attained a speed of about 6 knots.

Mr. Parsons then spoke briefly of the Fontaine Locomotive built by the Grant Locomotive Company of Paterson, N. J., and concluded his lecture by giving a short description of the Keely Motor. This motor was a machine invented by John W. Keely, a carpenter, who was born in Philadelphia in 1837 and died there in November, 1898, purporting to furnish motive power at a minimum expenditure of energy. It began to attract attention in 1874, and for several years excited wide interest. Its inventor made many startling claims and predictions for the success of his motors, asserting that they were destined to revolutionize mechanics. Several hundred thousand dollars were subscribed for the stock of the company formed to control the invention, and while the nature of the machine was kept a carefully guarded secret, it was widely exploited and attracted considerable attention. Various exhibitions were given, with some remarkable features; but the promised developments never appeared, and after the inventor's death the fraud was thoroughly exposed, it being shown that the force was supplied by a hidden compressed air apparatus.

THROOP COLLEGE OF TECHNOLOGY

The Throop College of Technology Student Branch held a meeting on April 28, at which R. O. Catland, '15, and Junior Member Am. Soc. M.E., spoke on a New Light Weight High Compression Aeroplane Engine which is being built by the Griffith Machine Company. The engines will probably be used on the new Martin aeroplanes. The motors are of the eight cylinder V type, 4⅝ in. bore by 7 in. stroke, and weigh about 485 lb. The cylinders are turned separately from solid stock, and after being fitted on the crank case they are ground to 3/16 in. thickness. A pair of cylinders is enclosed in a pressed steel water jacket made in two parts and welded in place. There are two intake and two exhaust valves for each cylinder. Due to careful designing of cylinders and water jacketing, the compression pressure is very high in this engine. The mean effective pressure has been calculated to be about 116 lb. per sq. in.

Much use is made of oxy-acetylene welding in the construction, the water jackets, exhaust and intake manifolds and the valve seats being welded.

During a recent test one of the engines developed 183 h.p. at 1375 r.p.m.

UNIVERSITY OF CALIFORNIA

At a special meeting of the University of California Student Branch held on April 13, 1916, G. W. Dickie, Vice-President of the Society, delivered an address on the subject of Work. He told of the various problems that young engineers would meet upon graduation, and showed the need of technical men in the foundry business. In concluding, the speaker touched the problems confronting the national board of engineers which was recently appointed to investigate the manufacturing resources of this country.

On April 18, 1916, the final meeting of the year was held. The following officers were elected for the coming year: Prof. L. B. Langille, honorary chairman; H. Greenwood, chairman; H. S. Bean, vice-chairman; H. G. Oliver, treasurer, and M. D. Penfield, treasurer. Following the election of officers the following papers were presented: The Development of Manual Training Instructors, by E. R. Foster, '17, and The Theory of Splashes and Methods Employed in Their Analysis, by B. R. Vanleer, Instructor in Hydraulics.

UNIVERSITY OF CINCINNATI

The University of Cincinnati Student Branch of the Society held a meeting on March 24, at which C. W. Heath, Chief Smoke Inspector of the City of Cincinnati, addressed the Branch. He told of the work of his department, the methods employed in handling different situations and the results obtained. He also told of the different smoke consuming devices and of the necessity of their proper use for results. His lecture was illustrated by means of lantern slides and moving pictures.

At a meeting of this Branch on April 27, M. Boyd Gordon, Member of the Branch, presented a paper on A New Type of Valve for Unaflow Engines. He described the workings of the valve and the ease of manufacture and the advantages which it is hoped this valve will have over others.

UNIVERSITY OF ILLINOIS

A meeting of the University of Illinois Student Branch was held on May 10, 1916, at which motion pictures were shown of manufacturing processes in the Ford Motor Car factory, and also of the American Railway Ditch Digger.

UNIVERSITY OF MINNESOTA

The University of Minnesota Student Branch held its regular monthly meeting on April 29, 1916. C. W. Tubby, Chairman of the Minnesota Section of the Society, gave an instructive and interesting talk on Pumping Machinery.

WASHINGTON UNIVERSITY

Last fall the Student Branch of Washington University formulated a new plan for its meetings, which was to have the students give papers before the Branch. This plan has been worked out and has proved to be very interesting as well as instructive. The Branch has had some outside speakers, however, among whom are the following: Thomas R. Beebe of the Oxweld Acetylene Company, who gave a demonstrative talk on oxy-acetylene welding and cutting. Members of the Branch were allowed to try their skill with the cutting torch and made to feel some of the difficulties encountered by the oxy-acetylene workers on particular classes of work.

Henry Gulick of the Moore-Jones Brass Company delivered a very interesting talk on Engineering Bronzes. Mr. Gulick, who is an expert on bronzes, told of some of the difficulties attending the fulfillment of requirements of certain specifications regarding tensile strength, hardness, etc., and also how to get around them.

Osborn Monnett of the American Radiator Company, who is an authority on boilers and boiler settings, gave an illustrated talk on The Elimination of Smoke with the Use of Any Soft Coal.

Some of the papers which were given by student members were the following: The Mallet Articulated Compound Locomotive by Walter H. Kurtz; Lodge and Shipley Lathes by Charles V. Brady. This was illustrated by lantern slides from the Lodge & Shipley Company. The Solution Theory of Metals presented by Harold C. Keyser, and Keokuk Power Plant by Percy N. Lubke. This was also illustrated with slides.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to make the office of the Soceity the medium for assisting members to secure positions, and is pleased to receive requests both for positions and for men. Copy for the Bulletin must be in hand before the 18th of the month. The notices appear in the Employment Bulletin in a form which indicates the classification.

POSITIONS AVAILABLE

These advertisements are placed by members of the Society or persons vouched for by members.. The Society is pleased to act as a "clearing house" in these matters but is not responsible for any result.

In forwarding applications, stamps should be enclosed for their transmittal to advertiscrs; and applications from non-members should be accompanied by a letter of reference or introduction from a member, to be filed by the Society.

ENGINEER. Technical graduate preferred, experienced in the design of open feed water heaters, softeners, etc. Good position to right man. Write fully giving details of experience and references.—102.

DRAFTSMEN—preferably men experienced in apparatus layout especially chemical apparatus and plants. Location New York.—267.

CHIEF DRAFTSMAN. Mechanical engineer with manufacturing experience on products similar to sewing machines and cream separators. Man thoroughly experienced in design of jigs, tools, fixtures and special machines for manufacturing parts on interchangeable basis. Salary to start $175 a month to thoroughly competent man.—268.

COST MAN, thoroughly familiar with estimating from blue prints, stock records, detail and final costs, etc.: good personality required and ability to handle men; must be capable of analyzing costs into operations. A systematizer is not wanted, but one who can maintain the present system and get results. Location New England.—270.

ESTIMATOR, experienced in grey-iron and steel castings, pattern and machine work. Position calls for accuracy above everything else. Location Maryland.—273.

DRAFTSMAN, capable of working with an inventor in the designing of automatic machinery. Location New Jersey. —274.

SAFETY INSPECTORS. Two or three young M.E. graduates for accident and indemnity company. Reply through No. 275.

SALESMAN for soot blowers for marine trade; should have a fairly good acquaintance with shipbuilders and owners; familiarity with marine boilers desirable.—276.

DRAFTSMAN, with technical training and considerable experience in design of air compressors. Salary $1200 to $1400 a year. Location Colorado.—280.

TOOL DESIGNER to take charge of tool drafting department, in concern manufacturing small interchangeable parts; man

preferred who has experience in tool design for concerns making typewriters, adding machines, electrical apparatus, etc. In reply state age, nationality, former places of employment, experience and salary expected. Location New England.—288

CHIEF ENGINEER. A man of generally well balanced mind and natural executive ability, good technical training, either college or self-taught. About ten years experience in automobile engineering and particularly in the branches of the profession pertaining to the engine design, carburation and production, qualifying him to take charge of production to the end of turning out thoroughly standardized parts, within necessary limits, and at a minimum cost; personal resourcefulness to devise new methods and ability to design interchangeable parts. Name confidential. Apply by letter.—289.

SALES ENGINEER, good personality, reasonably pleasant manners and tact, whose education has fitted him to meet engineers of vehicle manufacturers; applicant should have had five to eight years practical experience along the lines involved in power production, power requirements for the different gears, the relations and relative efficiency of gear ratios and carburation; should thoroughly appreciate the value of coöperation between himself and the other departments of the enterprise, and members of the various departments. Name confidential. Apply by letter.—290.

ASSOCIATE PROFESSOR IN EXPERIMENTAL MECHANICAL ENGINEERING in large engineering school in Atlanta, Ga., wanted next September. Must have recognized engineering degree and teaching experience or extensive practical experience in experimental and research work. Give full details of education, post-graduate work and practical experience, including references.—293.

MACHINE DESIGNER. A high grade machine designer or chief draftsman. Must be thoroughly versed with machine shop, drawing room, foundry and pattern shop practice. Write fully, giving details of experience, salary expectations, etc. Location Midle West.—295.

ENGINEER, experienced in design and construction of brass and other alloy foundries; state salary and experience. Location, New York.—297.

DRAFTSMAN, originality required, with some shop experience and a knowledge of shop technique; including design of small machines, detailing of repair parts for hydraulic presses and pumps, lay out of high pressure lines and enough skill to select and adapt conveyors from the manufacturers catalogues. Salary $125 per month to start. Location Canada.—298.

TECHNICAL GRADUATE IN MECHANICAL ENGINEERING, who has been out of college at least one year; to work in engineering departments and specialize along combustion and steam lines. Location Maine.—299.

ENGINEER OF TESTS AND OF REPORTS; one who has had wide experience in the testing of materials in construction and can prepare reports covering such tests. Good salary for the right man, but must fill requirements of education, experience and personality. Prefer man between thirty and forty years of age, who is at the present time employed, and who has made good where he is. Location Pennsylvania.—300.

SALESMAN AND SALES MANAGER for new aeroplane company; must be high grade salesman as well as organizer of salesmen. Apply by letter.—301.

MECHANICAL AND ELECTRICAL ENGINEER, who is a capable machine designer, wanted as assistant to the general manager of an old established company, making a line of machines used by metal manufacturers. The company expects to redesign its line and to do experimental and development work in connection with adapting its product to more extensive use. State age, education, experience and salary expected. Location New England.—303.

HIGH GRADE MACHINERY SALESMAN wanted by old established company making a line of machines used by metal goods manufacturer. Position involves large amount of travelling in the East, Middle West, etc. Qualifications desired: pleasing personality, energy, ambition, enthusiasm, imagination and ability to sell and to keep every customer satisfied. One who has demonstrated his ability along these lines. In reply give age, full record, and salary desired. A good position is offered at once, with interesting possibilities for the future. Headquarters New England.—304.

CHIEF ENGINEER with extended experience in both pleasure automobile and motor truck construction. Write The Timken Roller Bearing Company, Canton, Ohio.—307.

ENGINEERS. Firm of industrial engineers, foundry and metallurgical specialists, desires two or more men to assist in laying out foundry plans and looking after work; one prospect will involve a continuous foundry with considerable equipment and handling appliances.—308.

LABORATORY ASSISTANT for department of physics in an Eastern technical school. Candidate should be willing to start at the bottom and grow up with the work. Salary $800 to start. No teaching experience required.—309.

DESIGNERS, experienced jig and fixture designers for automobile work. Large company in Middle West. All new equipment. Good opportunity.—312.

MASTER MECHANIC to supervise tool, jig, fixture, design and maintenance for concern in Detroit doing brass work exclusively and employing about 60 toolmakers in tool room. Location Middle West.—322.

PRACTICAL ENGINEER to assist in design, building and putting into operation of tools for sheet metal work in general, and can-making tools of all varieties in particular. Thorough technical education a necessity. Preference given to man with experience in sheet metal work and in can-making. Salary $1800 per year, to be advanced as warranted by increased efficiency and familiarity with work. Location New York.—323.

ENGINEER having extensive experience in conveying machinery, able to handle layouts of equipment and methods and produce satisfactory and efficient results. Location Ohio.—324.

ASSISTANT SHOP ENGINEER familiar with woodworking machinery, to look after production side of work and upkeep. Location Vermont.—327.

TECHNICAL GRADUATE, 30 to 35, with practical experience in manufacture and building of steam and hydraulic machinery. Man preferred with wide shop experience, capable of directing men. Location, Ohio. Interview will be arranged only after examination of applicant's statement of qualification, records and compensation expected.—328.

MEN AVAILABLE

Only members of the Society are listed in the published notices. Notices are not repeated in consecutive issues of the Bulletin.

Members sending in notices for the Men Available section are particularly requested in the future to indicate the classification under which they desire their notices to appear.

SALES ENGINEER, graduate with six years' experience in design and manufacturing, wishes to enter firm which will train him in selling. Excellent references from present and past employers.—F-208.

ASSISTANT PROFESSOR. Member of Am.Soc.M.E. and S.P.E.E.; at present connected with mechanical engineering department of prominent university but desires to change position; would consider similar position which offers opportunity for advancement.—F-209.

STUDENT MEMBER, 1916, graduate in mechanical engineer-

ing, University of Minnesota; record good; desires position with engineering or manufacturing concern.—F-210.

MECHANICAL ENGINEER. Member, experienced in power plant design, heating, ventilating, industrial plants, selling experience, seeks responsible position; has had charge of men and shown executive ability.—F-211.

INSTRUCTOR or ASSISTANT PROFESSOR. Young engineer, at present in charge of courses in engineering laboratory in prominent Eastern university, experience in teaching nearly all branches of mechanical engineering, and about four years practical experience in drafting room and shop, desires position in college receiving state support, east or middle west preferred; references furnished and adequate reasons for desiring change.—F-212.

DEPARTMENT HEAD; mechanical engineer, university graduate, wide experience in efficiency work; steam engines, boilers, pumps, oil engines, water supply; especially familiar with air machinery; technical author, lecturer and editor; shop work, design and testing; also several years in sales engineering. Age 36; married, now employed, desires position offering better future. American.—F-213.

MECHANICAL ENGINEER, inventive and executive ability, A-1 references; member, twenty years experience steam, gas power, industrial and chemical plants; heating, ventilating, refrigeration, gas engines.—F-214.

ASSISTANT TO CHIEF EXECUTIVE OF LARGE CORPORATION, chief engineer or works manager, associate-member, 34 years of age broad, practical experience in electrical railway construction and operation, automobile manufacturing, machine tool building; speaks and writes French fluently, also some Spanish.—F-215.

ASSISTANT TO AN EXECUTIVE, 33, technical man, hard worker and strict disciplinarian, wishes to make a change; strong organizer and successful handling men. Experienced in the manufacture of heavy machinery. Best of references; valuable to executive needing man to take care of details and to see that orders are carried out.—F-216.

MASTER MECHANIC, SHOP SUPERINTENDENT or MANAGER, about 15 years experience at the machinist trade. Will graduate B.S. in M.E. from Bucknell University in June. Familiar with scientific management and methods; good references from reliable steel manufacturing firms and machine tool manufacturers.—F-217.

SHORT TERM EMPLOYMENT, June 8 to September 15, desired by mechanical engineer, student member from M.I.T. Four years designing, executive and teaching experience; heavy machine tool building, iron founding, gas engineering. —F-218.

ASSISTANT TO WORKS MANAGER or EXECUTIVE ENGINEER; technical graduate, with varied experience in office, sales and executive work in shop and factory, desires to become identified with concern where position would develop into broad future.—F-219.

GRADUATE MECHANICAL ENGINEER; thoroughly familiar with heat insulating materials; experienced in design and construction of cold storage rooms and warehouses. At present employed, but desires better opportunity for advancement.—F-220.

TESTING ENGINEER; technical graduate with four and a half years experience as assistant engineer in large laboratory testing steam machinery of all kinds, desires to make change.—F-221.

STUDENT MEMBER, will graduate in June in mechanical engineering from Rensselaer Polytechnic Institute, desires position with opportunity for advancement, in power plant work, heating and ventilating or efficiency work with manufacturing firm. Age 26.—F-222.

EXECUTIVE or ASSISTANT TO EXECUTIVE; technical graduate, (M.E.) at present employed, desirous of becoming connected with firm in or around New York City. Experience along executive, engineering, shop and sales lines. Speaks French and German.—F-223.

ASSISTANT TO EXECUTIVE, LARGE MANUFACTURING CORPORATION, to increase output, lower costs, unify and stimulate organization, through intensive, analytical methods. Past seven years in industrial management work; as member of staff of noted efficiency engineer, as assistant to comptroller, special investigator, manager manufacturing plant, overseeing economical operation all plants $10,000 corporation; as assistant to vice-president and to general superintendent $75,000 corporation to promote more intensive and analytical methods of operation; seeks permanent connection; age 31; technical graduate; references from previous connections. —F-224.

GRADUATE MECHANICAL ENGINEER with experience as machinist, tool and die maker, tool department sub-foreman and foreman, tool and machine designer, design inspector, acting equipment engineer, production supervisor; thorough knowledge of mechanics, mathematics, economics, manufacturing methods, factory organization, equipment management, men; time and motion study investigations and improvements.—F-225.

MECHANICAL ENGINEER with shop, drawing room and sales experience desires responsible position with growing concern, 30 years of age, married; highest references. Available July 1.—F-226.

MECHANICAL ENGINEER, experienced in design and operation of power plants and general manufacturing machinery; specialized in boiler room management and maintenance of machinery.—F-227.

ASSISTANT TO ENGINEER or INSTRUCTOR IN TECHNICAL SCHOOL. Junior member, college graduate, age 24; married; experience in drafting and shop. Desires permanent position as assistant to consulting engineer or as instructor in mechanical engineering. At present employed on valuation of common carriers. Can furnish satisfactory references.—F-228.

CHIEF, MECHANICAL or CONSULTING ENGINEER. Associate, technical education; fourteen years experience, familiar with design of industrial plants, mill buildings, ore blasting furnaces, coal washing, screening, elevating and conveying machinery, having held positions as chief draftsman, engineer of construction and chief engineer for large concerns.—F-229.

REPRESENTATIVE FOR THE FAR EAST. Japanese graduate of electrical and mechanical schools, connected with telephone and railway companies of New York, wishes to communicate with American firms planning to develop business in Japan or China. Will consider agencies.—F-230.

PROFESSOR OF MECHANICAL ENGINEERING IN A UNIVERSITY, desired by member, age 40, technical graduate, M.E. with 17 years experience in teaching engineering and consulting work; practical experience in commercial engineering; specialized in steam power plants; for a number of years head of department of mechanical engineering in leading university. At present head of departments of mechanical and electrical engineering in university of good standing. Location abroad, China preferred.—F-231.

MECHANICAL ELECTRICAL ENGINEER, age 32, married, fourteen years manufacturing experience as workman mechanical electrical engineer and engineer-in-charge of factory reorganization work. Experienced in analyzing industrial conditions, time study and task setting.—F-232.

EFFICIENCY ENGINEER, DRAFTSMAN and DESIGNER of automatic machinery, factory and mill buildings and labor saving devices; permanent position only in vicinity of New York City considered.—F233.

MECHANICAL ENGINEER, MASTER MECHANIC, or ASSISTANT, Junior member, technical education, age 31, varied experience, foundry and machine shop practice; design construction, and supervision of installation of mechanical equipment of textile machinery for print works, bleacheries and cotton mills, power transmission appliances, buildings and power plants, boilers, etc.; remodeling, maintenance, efficiency and general plant

engineering, purchasing materials and equipment, correspondence, estimates, specifications, contracts and appraisals; fire service, piping, sewage disposal for steam buildings and supervising steam engine, turbines and boiler tests. Can handle men and get results. Desires to locate with concern where ability and energy are required. At present employed. —F-234.

HYDRAULIC ENGINEER, graduate Worcester Polytechnic Institute, 16 years experience in hydraulic and pumping machinery in design, manufacturing and selling departments. Best of references.—F-235.

MANAGER, ASSISTANT, SUPERINTENDENT, EXECUTIVE or SALES ENGINEER. Associate, age 42, Lehigh University graduate in mechanical engineering; varied experience along mechanical, electrical and civil engineering lines involving design, inspection reports, responsible charge of construction work, plant operation, management, purchasing, etc., in connection with power, lighting plants and industrial plants, electric railways, etc. Salary, $3,000.—F-236.

MANAGER or GENERAL SUPERINTENDENT. Shipbuilding in all branches. Marine or stationary engines, power plant machinery and installations. Steam engineering and general machinery. No mechanical undertaking too large. Can furnish best of references of ability gained by years of practical work and supervision. At present employed; confidential. —F-237.

MECHANICAL ENGINEER, Columbia University technical graduate, desires to locate with manufacturing or engineering concern in or near New York; two years power plant, shop and drafting room experience. Experienced in power plant testing, automatic machinery, installation and layout of machinery. At present employed in maintenance department of concern manufacturing automobile auxiliaries.—F-238.

MECHANICAL ENGINEER, 1915 graduate, desires position with manufacturing concern where prospects of advancement are assured; experimental engineering experience. At present employed. Location preferred, New York.—F-239.

HEAD OF MECHANICAL ENGINEERING DEPARTMENT in educational institution or in charge of industrial education with manufacturing company. Teacher of experience who can furnish the highest recommendations from employers and associates. Wide experience in engineering and construction; now on the engineering force of a large manufacturing company.—F-240.

ADMINISTRATIVE or EXECUTIVE position. Member; technical and commercial training, at present employed, desires to become identified with manufacturing or industrial plant in responsible position. Varied experience in design and construction of machinery and buildings; remodeling, maintenance and operation of industrial plants and equipment; systematizing of shops and processes along scientific management lines; familiar with the handling of men, drawing up contracts, purchasing equipment and material; modern methods of manufacturing and marketing product.—F-241.

MECHANICAL ENGINEER. Member, who will shortly be in New York for several months, is open to negotiate with prominent manufacturers of railway rolling stock and specialties, with a view to representing them in Europe. Please address all communications to the Society.—F-242.

ENGINEER AND SUPERINTENDENT, Cornell graduate with extensive experience in designing, purchasing, constructing and operating power plants, track work, transmission and distribution lines, car barns, office buildings, foundries, machine shops, chemical and cotton plants, tanneries, gun cotton and smokeless powder plants, factories of reinforced concrete, flat slab or mill construction, also artesian wells, structural steel, docks, piling, sewers, heating, drying and air washer systems. Salary $4,000.—F-243.

SALES ENGINEER. Technical graduate, twelve years selling experience, especially Government work. At present in charge of Washington, D. C., office of large machinery manufacturer; desires similar position in New York.—F-244.

ACCESSIONS TO THE LIBRARY

A List of Books and Pamphlets Added During the Past Month to the Library of the Society and of the United Engineering Society, Engineering Societies Building, New York

ADDITIONS BY THE SOCIETY

This list includes only accessions to the library of this Society. Lists of accessions to the libraries of the A.I.E.E. and A.I.M.E. can be secured on request from Calvin W. Rice, Secretary of Am. Soc. M. E.

AIDS IN NAVIGATION (Cummings Engine Log System). *Boston.* Gift of A. S. M. E.

ATLANTIC DEEPER WATERWAYS ASSOCIATION. Proceedings. 8th Annual Convention. *Philadelphia, 1916.* Gift of Association.

CARNEGIE FREE LIBRARY. 23d and 27th Annual Report of Carnegie Club, Braddock, Pa. *1915.* Gift of A. S. M. E.

THE DANGERS OF HALF-TRUTH IN THE POWER PLANT; THE BUSINESS OF MAKING YOUR OWN POWER AT A PROFIT. *New York, Fuel Engineering Company, 1916.* Gift of publisher.

DEAN GRATES, DUMPING, SHAKING, STATIONARY. Catalogue no. 7. *New York, Washburn & Granger.* Gift of A. S. M. E.

DEPRECIATION RESERVES AS AFFECTED BY PROPERTY GROWTH, L. R. Nash. Reprinted from American Economic Review, March, 1916. Gift of Stone & Webster Corporation.

LE FACTEUR HUMAIN DANS L'ORGANISATION DU TRAVAIL, James Hartness. *Paris, 1916.* Gift of author.

FATIGUE STUDY. The elimination of humanity's greatest unnecessary waste, Frank B. Gilbreth and Lillian M. Gilbreth. *New York, Sturgis & Walton, 1916.* Price, $1.50. Gift of Publishers.

A book that should interest not only engineers, but laymen as well. It takes up the general question of fatigue, and describes the methods of studying fatigue and the bearing of environment, lighting, ventilation, seats and work benches on fatigue. W. P. C.

MARKSMANSHIP IN SCHOOLS. *London, The Wilkinson Sword Co.* Gift of A. S. M. E.

NATIONAL COMMERCIAL GAS ASSOCIATION. Proceedings of the 11th Annual Convention, 1915. *New York, 1915.* Gift of Association.

NEW YORK CENTRAL RAILROAD COMPANY. Report of the Board of Directors to the Stockholders, 1915. *New York, 1915.* Gift of New York Central Railroad Company.

NEW YORK CITY BOARD OF WATER SUPPLY. Information for bidders, forms of proposal, contract, bond and certificates, specifications and drawings for furnishing and erecting fences in the vicinity of the Kensico Reservoir, Contract 173. 1916. Gift of Water Supply Board.

——— Information for bidders, forms of proposal, contract, bond and certificates, specifications and drawing for furnishing, delivering and installing steam heating systems in the Ashokan Lower Gate and the Kensico Lower Effluent Chambers. Contract 164.

——— For furnishing, delivering and erecting traveling crane equipment in chambers at Ashokan, Kensico and Hill View Reservoirs. Contract 95.

——— For surfacing with bituminous macadam and vitrified brick block portions of the highways at the Kensico Reservoir. Contract 171. Gift of New York City Board of Water Supply.

NEW YORK STATE ENGINEER & SURVEYOR. Annual Report, vol. I, 1915. *Albany, 1916.* Gift of State Engineer & Surveyor.

OIL FUEL, Ernest H. Peabody. Gift of Babcock & Wilcox Company.

THE PIANO PLAYER, HOW AND WHY, P. J. Mealil. *Summit, 1915.* Gift of author.

PLANNING OF ALASKAN PORTS, Paul Whitman. *Washington, 1916.* Gift of U. S. Dept. of the Interior.

RAILWAY REGULATIONS, John Findlay Wallace. Rand-McNally Bankers' Monthly, April, 1916. Gift of J. F. Wallace.

REPORT ON THE FEASIBILITY AND ADVISABILITY OF SOME POLICY TO INAUGURATE A SYSTEM OF RIFLE PRACTICE THROUGHOUT THE PUBLIC SCHOOLS OF THE COUNTRY, G. W. Wingate and A. B. Critchfield. *Washington, 1907.* Gift of A. S. M. E.

SOCIETY OF CONSTRUCTORS OF FEDERAL BUILDINGS. List of Members, 1916. Gift of A. S. M. E.

SOCIETY OF NAVAL ARCHITECTS & MARINE ENGINEERS. List of Members, 1915. Gift of A. S. M. E.

SOME HAZARDS AND SAFETY SUGGESTIONS IN CONNECTION WITH CONSTRUCTION, INSPECTION AND MAINTENANCE OF PUBLIC UTILITIES, H. W. Mowery. Gift of A. S. M. E.

STAIR AND SIDEWALK HAZARDS. From the report to the Mayor's safety committee by the American Museum of Safety. Gift of A. S. M. E.

SUBMARINE NAVIGATION, BY THE AID OF CUMMINGS ENGINE LOG SYSTEM. *Boston.* Gift of A. S. M. E.

SUB-TARGET GUN MACHINE, DESCRIPTION OF. *Boston.* Gift of A. S. M. E.

TECHNICAL BOARD—Vessel safety to Council Committee, Harbors, Wharves and Bridges, City of Chicago. Report, March, 1916. Gift of Technical Board—Vessel Safety.

TEXT BOOK OF MECHANICS, Louis A. Martin, Jr. Vol. VI. Thermodynamics. *New York, J. Wiley & Sons, 1916.* Gift of publisher. Price, $1.75.

An elementary textbook for mechanical engineering students.

W. P. C.

EXCHANGES

INSTITUTION OF MECHANICAL ENGINEERS. Proceedings, Oct.-Dec., 1915. *London, 1915.*

THE LOCOMOTIVE. Vol. XXX. Hartford Steam Boiler Inspection and Insurance Company. *Hartford, 1914-1915.*

TRADE CATALOGUES

AMERICAN MANGANESE STEEL CO. *Chicago, Ill.* Bulletin 65. Manganese Steel Castings for Steam Shovels and Dipper Dredges.

BAILEY METER CO. *Boston, Mass.* Bulletin No. 5. Bailey Fluid Meter, Type C 2. *Jan., 1916.*

BAIRD MACHINE CO. *Bridgeport, Conn.* Master Bulletin. "Brief bits 'bout Baird Machinery." *Nov., 1911.*

BECKER MILLING MACHINE CO. *Boston, Mass.* Becker Vertical and Horizontal Millers. *1916.*

CONTINENTAL GIN CO. *Atlanta, Ga.* Catalogue No. E-2. Continental Engines and Boilers.

——— G5, X7-E. Cotton Ginning Machinery; Continental Linter.

"DUPLEX" GIN SAW FILER (Wood's latest improved No. 3).

HEART OF THE GIN PLANT. 20 pp.

FLANNERY BOLT CO. *Pittsburgh, Pa.* Staybolts. *April, 1916.*

GOLDSCHMIDT THERMIT CO. *New York, N. Y.* Reactions. Vol. 9, no. 1. *1916.*

GOODRICH CO. *Akron, Ohio.* The Goodrich. *April, 1916.*

INGERSOLL RAND CO. *New York, N. Y.* Form no. 3026. "Ingersoll Rogler," Class "PRE," Duplex Direct Connected, Electrically Driven Air Compressors. *March, 1916.*

NORDBERG MFG. CO. *Milwaukee, Wis.* Bulletin no. 27A. High Compression Two-Sycle Oil Engine. *Sept., 1915.*

ROEBLING'S SONS CO. *Trenton, N. J.* Roebling Wire Rope. v. 1, no. 2.

STEPHENS-ADAMSON MFG. CO. *Aurora, Ill.* Labor Saver. *April, 1916.*

TEXAS OIL CO. *New York, N. Y.* Lubrication. *April, 1916.*

VALLEY IRON WORKS CO. *Appleton, Wis.* The Beater. March-April, *1916.*

ADDITIONS BY THE UNITED ENGINEERING SOCIETY

ALTERNATING CURRENT ELECTRICITY AND ITS APPLICATIONS TO INDUSTRY. Second Course, W. H. Trimie and H. H. Higbie. *New York, J. Wiley & Sons, 1916.* Price, $3 net. Gift of Publishers.

A textbook, with numerous problems for students. W. P. C.

AMERICAN CLAY MACHINERY COMPANY. Catalogue no. 95. Clay Working Machinery. Gift of Leon Goldmerstein.

AMERICAN SHIP-BUILDING COMPANY. Prospectus, Based upon the Patents of Capt. Augustus Walker. *New York, 1864.*

AMERICAN YEAR BOOK, 1915. Edited by F. G. Wickware. *New York-London, 1916.*

ANALYSIS OF DYESTUFFS AND THEIR IDENTIFICATION IN DYED AND COLORED MATERIALS, LAKE PIGMENTS, FOODSTUFFS, A. G. Green. *London, 1915.*

ARTESIAN WELLS OF MONTREAL. Canada. Department of Mines, Memoir 74. *Ottawa, 1915.*

SIR HENRY BESSEMER. An Autobiography. *London, 1905.*

BURNETTIZING, OR THE PROCESS FOR PREVENTING THE RAPID DECAY OF TIMBER BY THE USE OF CHLORIDE OF ZINC. *Cambridge, 1856.*

THE BY-PRODUCTS OF COAL GAS MANUFACTURE, K. R. Lange; translated from the German by Chas. Salter. *London, 1915.*

CANADA. MINES BRANCH. DEPARTMENT OF MINES. Description of the Laboratories. *Ottawa, 1916.*

EL CANON KRUPP Y EL SCHNEIDER DE 75 MILIMETROS, A. F. Dalmau. *Barcelona, 1915.*

CASTING OF CLAY WARES. U. S. Bureau of Mines. Technical Paper 126. *Washington, 1916.*

CHEMISCHE TECHNOLOGIE DES ERDÖLS, Richard Kissling. *Braunschweig, 1915.*

CHEMISCHE TECHNOLOGIE DES LEUCHTGASES, Karl Th. Volkmann. *Leipzig, 1915.*

CIRCULAR OF WILLIAM A. ORCUTT, Manufacturer of Orcutt's Patent Lightning Rods. *Boston, 1866.*

COAL AND COKE, F. H. Wagner. *New York, 1916.*

COAL RESOURCES OF DISTRICT VIII, DANVILLE. Illinois Coal Mining Investigations. Bulletin 14. *Urbana, 1915.*

DESCRIPTION OF EDWARD MASSEY'S NEW IMPROVED PATENT PERPETUAL LOG, AND PATENT SOUNDING MACHINES. *London.*

DICTIONARY OF ALTITUDES IN THE DOMINION OF CANADA, Jas. White ed. 2. *Ottawa, 1916.*

DIE DIFFERENTIALGLEICHUNGEN DES INGENIEURS, W. Hort. *Berlin, 1914.*

DIRECTIONS FOR DESIGNING, MAKING AND OPERATING HIGH PRESSURE TRANSFORMERS, F. E. Austin. *Montpelier, Vt., 1914.*

DIRECTORY OF DIRECTORS IN THE CITY OF NEW YORK, 1915-1916. *New York, 1916.*

EFFECT OF PRELIMINARY HEATING TREATMENT UPON THE DRYING OF CLAYS, A. V. Bleininger. *Washington, 1911.*

EXPLOSIBILITY OF GASES FROM MINE FIRES. U. S. Bureau of Mines. Technical Paper 134. *Washington, 1915.*

FESTIGKEITSEIGENSCHAFTEN UND GEFÜGEBILDER DER KONSTRUKTIONSMATERIALIEN, C. Bach und R. Baumann. *Berlin, 1915.*

FOREST PROTECTION IN CANADA, 1913-14. *Toronto, 1915.* Gift of Canada. Commission of Conservation.

FORGING OF IRON AND STEEL, W. A. Richards. *New York, 1915.*

FRANKLIN INSTITUTE. Report of the Committee for the Promotion of the Mechanic Arts on the Explosions of Steam Boilers. Part 1-II. *Philadelphia, 1836, 1837.*

GEOLOGY AND GEOGRAPHY OF THE GALENA AND ELIZABETH QUADRANGLES. Bulletin No. 26, Illinois State Geological Survey. *Urbana, 1916.*

GEOLOGY OF CRANBROOK MAP-AREA, BRITISH COLUMBIA. Canada. Department of Mines. Memoir 76. *Ottawa, 1915.*

GLYCERINE, ITS PRODUCTION, USES AND EXAMINATION FOR CHEMISTS, ETC., S. W. Koppe; translated from the German second edition by W. H. Simmons. *London, 1915.*

HANDBOOK FOR THE ARTISAN, MECHANIC AND ENGINEER. Oliver Byrne. *Philadelphia, 1870.*

HANDBOOK TO THE COLLECTION OF KAOLIN, CHINA-CLAY AND CHINA-STONE IN THE MUSEUM OF PRACTICAL GEOLOGY, J. A. Howe. *London, 1914.*

HANDLING MATERIALS IN MANUFACTURING PLANTS, Robert L. Streeter. The Engineering Magazine, vol. 1, no. 6, March 1916, 26 pp., 33 figs.

HANDBUCH DER STEININDUSTRIE, C. Gabert, A. Spielmann and A. Steuer. vols. 1-2. *Berlin, 1916.*

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[1] A complete list of the officers and committees of the Society will be found in the Year Book for 1916, and in the February 1916 issue of The Journal.

ENGINEERING SURVEY

A Review of Engineering Publications in All Languages. All the leading periodicals of the engineering world, embracing over 1000 different publications, are received at the Library. These are systematically examined for review each month in the Survey.

SUBJECTS OF ABSTRACTS

ARRANGED IN THE ORDER OF THEIR APPEARANCE IN THE SURVEY.

AEROPLANE SURFACES, RESISTANCE.
SCREW SURFACES (PROPELLERS), CHARACTERISTICS OF RESISTANCE.
WIND TUNNEL EXPERIMENTS, DIMENSIONAL THEORY.
TOTALLY IMMERSED BODY, EQUATION OF RESISTANCE.
VISCOSITY OF AIR AND HEAD RESISTANCE OF AIRSHIP.
DYNAMICAL SIMILARITY OF MODELS OF AIRCRAFT.
CORRESPONDING SPEEDS OF MODELS OF AIRCRAFT.
WIND TUNNEL, MASSACHUSETTS INSTITUTE OF TECHNOLOGY.
STEEL, HEAT TREATMENT AND PHYSICAL PROPERTIES.
MALLEABLE IRON, FACTORS IN PRODUCTION.
FUEL ECONOMY COMMITTEE, BRITISH ASSOCIATION.
PIPE LINE TICKER SIGNAL APPARATUS.
PIPE LINE WARNING APPARATUS.
AUTOMOBILE ENGINES, CONSTANT-PRESSURE CYCLE.
LIMIT GAGE PRINCIPLES.
POWER MEASUREMENTS, SOURCES OF ERROR.
FAN DYNAMOMETER.
SURFACE FRICTION IN FLOW OF STEAM AND WATER.
NATURAL GAS, COMPRESSIBILITY AT HIGH PRESSURE.
FLOW IN PIPES, TURBULENT.
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WHIRLS IN AIR, VIBRATORY.
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INCREASING VELOCITY OF GASES IN LANCASHIRE BOILER.
THOMSON-JOULE EFFECT IN AIR, AND TEMPERATURE AND PRESSURE.
STEEL TUBING, MANUFACTURE BY WELDING.
CHARTS.

THIS MONTH'S ARTICLES

The articles in the section Aviation are characteristic of the rapid and growing development of this new branch of engineering. Among this month's abstracts is found an extensive investigation on the dimensional theory of wind tunnel experiments, by Edgar Buckingham, Mem. Am. Soc. M. E., carried out at the Smithsonian Institution, while the Massachusetts Institute of Technology is shown in an abstracted article by J. S. Hunsaker to have created an apparently well-equipped laboratory for aeronautical experimentation.

In the same section will be found an abstract of a paper by Prof. G. H. Bryan on the characteristics of certain resisting surfaces and screws. This paper is of an essentially critical nature and to be fully understood must be read in connection with the previous paper by a veteran of aviation, Capt. Ferber, who made an attempt to treat the entire problem of stability of heavier-than-air machines by means of an orthogonal system of planes.

In the section on Engineering Materials will be found a continuation of an article abstracted in the previous issue of The Journal, on the influence of heat treatment on certain physical properties of steel. In the present abstract are given data on the hardness of very low carbon steel as affected by annealing at various temperatures.

In the next section, Foundry, is a discussion of the interdependent relationship of the various factors in malleable iron production. Among other things, the author gives a control chart of malleable cast iron melting and annealing operation, which may be of considerable usefulness for one who wants to make certain that he thoroughly understands every step in the production of this important material.

A brief abstract is given of a paper before the Society of Chemical Industry by Prof. William A. Bone, of England, chairman of the Fuel Economy Committee of the British Association. The appointment of this Committee which, at least in this country, attracted only very little attention, is one of the significant indications of the profound changes which the present war in Europe is likely to bring for all time to come in the industrial life of the world. While the subject of economy was always one of favorite discussion, these discussions were mainly academic because the creation of economic conditions of production involves not only the changes in methods of operation but what is more, changes in that equipment with which the world's work is done, and industries are proverbially slow in sending to the scrap heap equipment which, however uneconomical, pays dividends. The war, by its upheaval in all relations of supply and demand, has forced the industries to consider the forms of production, not from the point of view of current balances of income and expense, but as an element in the national struggle for existence in which economy of operation becomes the imperative condition of survival. It made clear that the change of industrial and trade policies, partly already accomplished and still more impending after the conclusion of peace, will require an entire reconstruction of the whole age-old structure of production, and every nation is anxious that when this reconstruction is effected it should leave its methods of creation of values as economical and as efficient as possible. The British Association, a body representing the best scientific forces of the British Empire, has, with this view in mind, created a number of committees, that of Fuel Economy being naturally of greatest interest to mechanical engineers. It is significant that the first thing to which the chairman of that Committee calls attention is a great need of further experimental research upon the chemical character of coal. It is rather noteworthy because it carries with it the open confession that we are still very ignorant of the nature and properties

of that material on which the world has been mainly dependent for its power since the days of Newcomen's engine.

In the next section is described a pipe line installation in Nevada. The interest of this installation lies in the fact that as it had to be protected against excessive cold during certain parts of the year, automatic devices have been installed of apparently a simple and quite efficient nature.

Attention is called to the section on Measuring Instruments, among other things to the abstract of the article on the fan dynamometer, by J. Lawrence Hodgson, of interest because it gives information on how the resisting torque, due to the blades of a fan dynamometer, varies with their shape and size with the diameter of the fan and the density of the fluid in which the blades rotate. In the same section is an abstract from a French periodical discussing the various sources of error which are apt to affect the measurement of the power developed by engines. It is shown that when the propeller rotates inside of a large casing as is usually done in power tests, the error may be as high as 20 per cent.

Several articles on flow of fluids through pipes and the vortex formation in the air will be found in the section Physics.

The Simplex valve for Mallet type of locomotives is described in the section Railway Engineering.

Aeronautics

THE CHARACTERISTICS OF CERTAIN RESISTING SURFACES AND SCREWS, G. H. Bryan

The paper discusses the treatment of the problem of stability of heavier than air machines by Captain Ferber by means of an orthogonal system of planes.

The present paper deals with the properties of a system of rigidly connected non-interfering surface elements moving in a resisting medium and obeying the sine law of resistance. The application of the results to the specification of the forces and couples acting on an actual aeroplane is, therefore, subject to certain limitations and in particular the surfaces of an aeroplane must partake of the character of "narrow planes gliding at small angles" in order that the results may become applicable as first approximations. The article is of a strictly mathematical nature and only some of the conclusions arrived at are reported here.

Every resisting system of the kind referred to possesses three principal axes at right angles, such that a wind blowing in the direction of one of these axes produces no component pressure at right angles to that axis. The axes may, therefore, be described as axes of no-lift, since the lift of an aeroplane represents the component pressure perpendicular to the wind velocity.

A system having one plane of symmetry may be represented by Captain Ferber's equivalent system of three orthogonal planes for all variations of pressure depending on *motions of translation* of the system relative to the resisting medium, and the same result holds good for any such system provided that motion in the direction of a principal axis produces no couple about that axis. When, however, the system has a motion of rotation in addition to one of translation, the forces and couples on it are no longer equivalent to those on a system of three orthogonal planes, and failure to realize this fact was one of the causes which led Captain Ferber to obtain incorrect conditions of lateral stability.

Selig Brodetsky has investigated the conditions under which the system may be replaced, not by *three* orthogonal planes, but by *six* surfaces occurring in pairs, each pair being perpendicular to one of the co-ordinate axes. Under certain conditions he finds that six surfaces can be reduced in number to five, four and three. Professor Bryan claims, however, that when rotations are taken into account, the representation of the system by any equivalent system of orthogonal planes is only possible in the case of *small* oscillations or other disturbances about a state of steady motion in a direction nearly coinciding with the principal axis.

The author considers next the resistance derivatives of screws.

A qualitative estimate of the magnitudes of these derivatives can be obtained by assuming the blades to be "narrow surfaces gliding at small angles," i. e., by supposing that they can be regarded as built up of non-interfering surface elements the resistance on which follows the sine law. The author discusses mathematically the expressions for these derivatives and shows, *first*, that it is possible to select the coefficients in such a manner that the machine should not tend to dip up or down in turning curves, and, *second*, by taking the turning axis to be horizontal, it would similarly be possible to choose its position and that of the screw so that the lateral rotations are not set up when the system is being steered in a vertical plane (*The Aeronautical Journal*, vol. 20, no. 77, p. 3, January-March 1916, 7 pp. *mt*).

NOTES ON THE DIMENSIONAL THEORY OF WIND TUNNEL EXPERIMENTS, Edgar Buckingham

The purpose of the investigation has been to establish the conditions under which data obtained from tests on models may be applied to full-size originals.

In order that the results of observations on models shall be interpretable as definite statements about the behavior of the full-size original of which the model is a copy, certain requirements must be satisfied, and when they are satisfied the original and the geometrically similar model are said to be dynamically similar. The conditions for dynamical similarity are bound up with the general question of the possible forms of equations which describe relations subsisting among the physical quantities involved in physical phenomena.

If R be any force exerted by the ambient fluid on a body moving through it, R will depend on and be completely determined by the relative speed, the size, shape and attitude of the body and the mechanical properties of the fluid, and there must be a definite relation connecting these various physical quantities which can be described by an equation.

The properties of the fluid which determine its mechanical behavior are its density ρ, its viscosity μ, and its compressibility, but instead of the viscosity it is generally more convenient to use the kinematic viscosity $\nu = \mu/\rho$. Similarly, the speed, C, of sound waves in the fluid is fixed by the density and compressibility, so that conversely C and ρ fixes the compressibility, hence the properties of the fluid may be specified by stating the values of the density ρ, the kinematic viscosity ν and the acoustic speed, C, in the fluid.

The author deduces the following equation:

$$F\left(\frac{R}{\rho D^2 S^2}, \frac{DS}{\nu}, \frac{S}{C}, r', r'', \ldots\right) = 0 \qquad [1]$$

which is fundamental to the experimental study of hydrodynamic and aerodynamic forces acting on totally immersed bodies. In this equation D is some linear dimension of the body such as its greatest length, S is the constant velocity at which the body is moving, and r', r''.... are the ratios of a number of lengths to the particular length, D, which specify the shape of the body and its attitude, i.e., its orientation with regard to the direction of motion.

The simplification of this equation is possible when the motion is not rapid enough to cause any sensible compression in the fluid. In this event it is immaterial what the compressibility is so that S/C may be omitted from consideration and the equation reduces to

$$\frac{R}{\rho D^2 S^2} = \varphi\left(\frac{DS}{\nu}, r', r'', \ldots\right) \qquad [2]$$

It must be borne in mind that equation [2] would be entirely misleading if used in studying projectile resistances, but at the speeds which occur in aeronautics, with the exception of propeller tip speeds, the ratio S/C is a sufficiently small fraction to make legitimate an assumption that the air acts nearly like an incompressible fluid. This equation supplies the basis for an experimental investigation of the aerodynamic problems which occur in connection with aeronautics and aviation by means of reduced scale models.

The author shows that if a series of bodies of various sizes but of the same shape are presented to the wind in the same attitude, the equation which expresses the force exerted by the fluid on the body involves a certain function the nature of which will depend on the shape and attitude of the bodies but not on their size (provided the disregard of compressibility as stated above was a justifiable approximation).

The author finds further that the head resistance is proportional to the square of velocity and that in the equation which expresses it, viscosity does not appear. This is not equivalent to saying, however, that viscosity plays no part at all in the phenomena, for if viscosity did not exist there would be no eddies of finite size, no dissipation and, at a constant speed, no resistance. It means rather that the drag on the body by the fluid is due to the continual drain of energy needed to set up anew the turbulent eddying motion about the body and that when these eddies have once been created it makes no difference how fast they are dissipated by viscosity after the body has left them behind.

The writer further discusses the question of critical speed as it affects the head resistance of a body and shows that at a certain point the critical value may be reached where the ordinary expression for the relation between resistance and speed ceases to hold and the character of the fluid motion changes very rapidly though not discontinuously. The occurrence of a critical speed for a given body in a given attitude is paralleled by the occurrence of a critical attitude at a given speed. Just as the nature of the fluid motion and the law of resistance of a given body change rapidly at a certain critical range of speed so there are similar rapid changes in the motion of the forces at the critical angle of attack for a given aerofoil at a given speed.

The question of resistance of flat plates normal to the wind is discussed and the apparent irregularities in the variation of resistance as affected by D^2 are considered, the author suggesting that these variations are due to the fact that the compressibility of the fluid is not entirely negligible. Compression might occur locally in some parts of the field about the body to such an extent as to modify the flow and so affect the resistance.

The problem of dynamical similarity is stated as follows: Let us suppose that we are confronted with a problem of design which requires our knowing in advance the head resistance at a prescribed speed of some body, such as an airship, which is too large for direct experiment. How to get the desired information from experiments on a small model which can be made at a permissible cost?

From equation

$$R = \rho D^2 S^2 \varphi\left(\frac{DS}{\nu}, \frac{S}{C}\right) \qquad [3]$$

it is seen that whatever be the form of φ, if its two arguments have the same values during two different experiments on geometrically similar bodies, the value of φ itself will be the same in both experiments. This leads to the notion of "corresponding speeds" and "dynamical similarity." If we suppose that we require the resistance R of a body of size D at a speed S in a medium with the properties ρ, ν, and C and that we have a model of size D_m which can be run in a medium with the properties ρ_m, ν_m, and C_m, then we can run the model at a speed S_m such that

$$\frac{D_m S_m}{\nu_m} = \frac{DS}{\nu}, \text{ and } \frac{S_m}{C_m} = \frac{S}{C} \qquad [4]$$

Speeds which satisfy this last equation are "corresponding speeds" and when two geometrically similar bodies are run at corresponding speeds, they are "dynamically similar." On the other hand, it can be shown that geometrically similar bodies will be dynamically similar if their speeds are inversely as their linear dimensions. In some cases excessive reduction in scale might involve running the model so fast as to make the effects of compressibility no longer negligible, but if the original is to be run in air while the model can be run in water this difficulty may be avoided. In practice, however, under ordinary working conditions the resistance of aeroplanes and their separate structural elements are so nearly proportional to the square of the speed and the effects of compressibility are so small that for practical purposes φ in equation [3] may be treated as a constant (*Smithsonian Institution Report*, through *Aerial Age*, vol. 3, nos. 5 and 6, pp. 152 and 184, April 17 and 24, 1916, 4 pp. *t*).

The Wind Tunnel of the Massachusetts Institute of Technology, J. S. Hunsaker

Description of the installation of some of its equipment. The wind tunnel of the Massachusetts Institute of Technology essentially reproduces a similar installation at the National Physical Laboratory, Teddington, England, from which were obtained detailed plans and also the patterns from which the aerodynamical balance was made. From the work of the staff of the National Physical Laboratory, certain calculations applicable to wind tunnels generally have been reached, among them: (1) the suction side of a fan is fairly free from turbulence, (2) a fan made by a low pitch four-bladed propeller gives a steadier flow than the ordinary propeller fan used in ventilation, and a much steadier flow than fans of the Sirocco or centrifugal type, (3) a wind tunnel should be completely housed to avoid the effect of outside wind gusts, and (4) air from the propeller should be discharged into a large perforated box or diffuser to damp out the turbulent wake, and return the air at low velocity to the arm.

The wind tunnel proper is 16 sq. ft. in section and some 53 ft. in length. Models under test are mounted in the center of the square trunk on the vertical arm of the balance. Passing through the square trunk and past the model the air is drawn past a star-shaped longitudinal baffle into an expanding cone, the expansion of which is much larger than in the English tunnel.

The aerodynamical balance is essentially similar to that used in the National Physical Laboratory in England. It can be adusted to tilt for 1/10,000 lb. force on the model. In general, however, the precision of measurements is not so good as the sensitivity and in the end is limited by the steadiness

of the wind and the skill of the observer. The article describes the methods of alignment of the tunnel and alignment of vertical axes of the balance.

The velocity of flow in the wind tunnel is measured by a double Pitot tube calibrated at the National Physical Laboratory in England. Its disadvantage lies in the fact that it obstructs the channel, and where models are to be tested the channel should be kept entirely clear, hence the side hole method of measurement may be used and the article explains its principle. The pressure transmitted by the side plate is read on an inclined alcohol manometer on the Krell principle. The side plate and its manometer were calibrated together against the Pitot tube and a Chattock manometer (*The Technology*

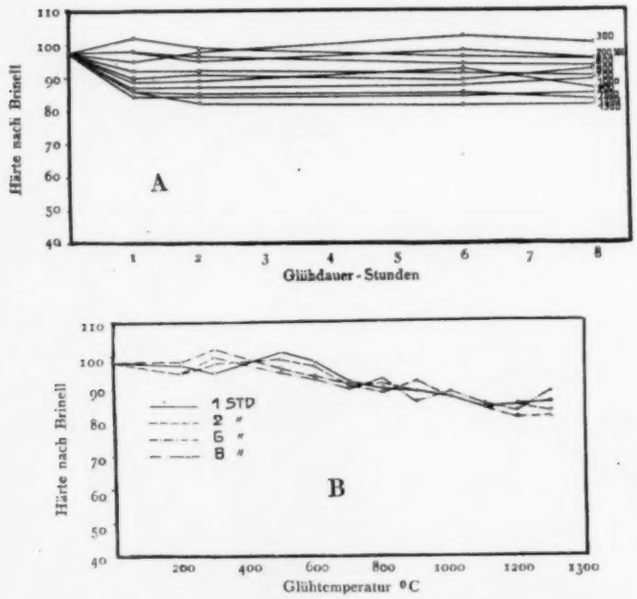

FIG. 1 FUNCTIONAL RELATION BETWEEN HARDNESS AND HEATING

Ordinates in both figures: Brinell hardness;
Abscissae in A: duration of heating in hours, in B: temperature of heating in deg. cent. In B: *Std* = hours.

Monthly and Harvard Engineering Journal, vol. 3, nos. 1 and 2, pp. 9 and 17, April and May, 1916, 8 pp. *d*).

Engineering Materials

INFLUENCE OF HEAT TREATMENT ON CERTAIN PHYSICAL PROPERTIES OF STEEL, A. Pomp

The article is a continuance of one abstracted in The Journal, May, 1916, page 421. In this part of the article the author presents some investigation on the hardness of mild wrought iron after annealing at various temperatures. The chief interest of the investigation lies in the fact that, as the author states, there are no published data on the hardness of this material under such conditions. It is, however, also of interest because the tensile strength and hardness of a material being approximately proportional to one another, variations of tensile strength due to heat treatment may be expected to produce concomitant variations in hardness.

H. Fay and S. Badlam have investigated the tensile strength of a low carbon steel (0.07 per cent carbon) heated in an electric muffle furnace up to temperatures of 1200 deg. cent., and have found only a very slight fall of tensile strength, viz., from 59,000 to 53,000 lb. per sq. in., at temperatures above 1100 deg. cent.

In the present test the hardness was determined by the Brinell method with a maximum pressure applied 1000 kg. (2200 lb.); diameter of the ball 5 mm. (0.196 in.); and duration of application of pressure 0.5 minutes.

The results of the Brinell test are given in Table 1 and graphically in Figs. 1A and B. Fig. A reproduces the hardness as a function of the duration of heating, the curves drawn being, therefore, lines of equal temperature, while in Fig. B hardness is represented as a function of the temperature applied, the curves being lines of equal duration of heating.

From these figures it appears that the variations of hardness with rise of temperature and increase in duration of heating up to temperatures of 600 deg cent. are only extremely slight, and do not exceed probable experimental errors. The values for hardness obtained with heating at temperatures of 700 deg cent. and up are from 5 to 10 Brinell units below those obtained with temperatures from zero to 600 deg. cent. This difference, however, is not material, and indicates only that at the higher temperatures of heating there occurs a certain, even though small, reduction of hardness,—an observation which is in accord with those previously made by Fay and Badlam.

A noteworthy fact is brought out by Fig. A, namely, that whether the duration of heating is one or eight hours, there is no material variation in the hardness of the metal.

With heating at the higher temperatures and for periods from 6 to 8 hours, a certain slight decarbonization of the materials under test could not be avoided. For example, the reduction of the carbon content in a test piece heated for 8 hours at 1200 deg. cent. amounted to 0.02 per cent, and if one considers that the total carbon content of the original material was only 0.08 per cent, the conclusion may be justified that the reduction of hardness which occurs with the rise of temperature of heating may be at least partly due to the decarbonization of the material (*Einfluss der Wärmebehandlung auf die Kerbzähigkeit, Korngrösse und Härte von kohlenstoffarmem Flusseisen*, A. Pomp, *Ferrum*, vol. 13, no. 5, p. 65, February, 1916. *eA*).

Foundry

VARIABLE FACTORS IN MALLEABLE IRON PRODUCTION, L. E. Gilmore

The article gives an outline showing the interdependent relationship of the various factors in malleable iron production, with some practical suggestions for the manufacture of this material.

In the production of malleable iron there are two requisites; first, the carbon of the white iron must be in chemical combination such that it is annealable; and second, the annealing must be such as will dissociate the carbon in combination as precipitated free carbon. All the variables preceding and during casting must be manipulated to attain the first mentioned condition and all the variables of the annealing operation must be regulated to produce the second requisite.

The author gives a control chart (Fig. 2) of malleable cast iron melting and annealing operations. Other variables being constant, the higher the casting temperature and the faster the rate of cooling, the greater the percentage of combined carbon. Further, the condition of the carbon is vitally influenced by the various chemical constituents of the iron, and the proper condition of combined carbon may be secured by varying percentages of silicon provided the carbon is correspondingly reduced as the silicon percentage is increased. The proper manipulation of the percentages of sulphur and man-

ganese will produce a similar effect. Finally, certain ferro-alloys have sufficient carbon to gray the white iron irrespectively of the effect of the other elements present in the alloy.

The next element is the type of furnace used, which imposes rigid limits on the chemical composition of the material. The details of construction of the furnace also determine the nature of the fuel used as well as its quality. A coke too high in ash and sulphur might make impossible the production of good malleable in a cupola. Another important factor in furnace operation is the nature and condition of the slag, as the retention or loss and the speed of elimination of certain chemical elements may be largely dependent upon the slag. The next item in furnace operation is the control of combustion, and finally, the human factor must not be lost sight ot.

The author summarizes the whole subject of furnace operation in two aims, that of melting the iron in the shortest possible time at least cost, and that of producing an iron hot enough to pour the work successfully.

The next question is what mix will produce the analysis of best composition. The ideal mix is that which will produce under the conditions of furnace operation the desired composition in the melted iron as soon as the iron is hot enough for pouring. In making up the mix, besides other things, the loss or increase in each element due to furnace conditions and methods of operation must be discounted. Besides its chemical analysis, the physical condition of the scrap and pig is a variable that has an important bearing upon the use of these materials. For example, sand-coated pig requires a greater length of time for melting, and the same holds good for material in large chunks. On the other hand very small pieces of metal may be detrimental when badly rusted, as this rust must be taken care of in the slag.

The essentials of the annealing operation are, first, the maximum temperature attained; second, the length of time held above the critical temperature; and, third, the rate of cooling through the critical range. The conditions of annealing are further affected by the thickness of castings and nature of packing. The aim in the construction of the annealing furnace and application of fuel is to furnish a means for rapidly heating the castings in all parts of the oven to as nearly uniform a temperature as possible and then maintaining this temperature a suitable length of time. The variables of the annealing operation are interdependent; for instance, an increased maximum temperature and shorter holding time may accomplish the same result as a lower maximum temperature with a longer holding time. The rate of cooling through the critical range may make or mar an otherwise perfect material (*The Foundry*, vol. 44, no. 5, p. 181, May 1916, 3 pp., 1 fig. *p*).

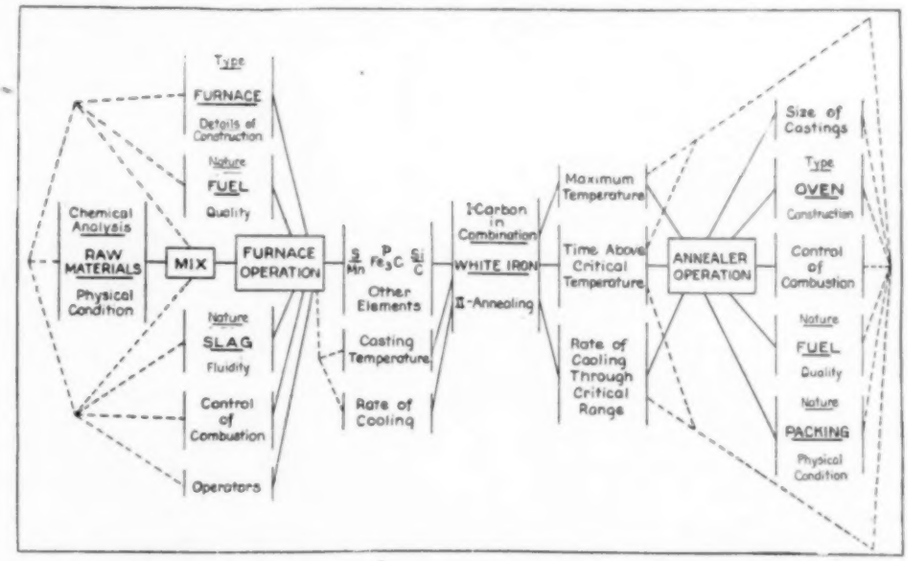

FIG. 2 CONTROL CHART OF MALLEABLE CAST IRON MELTING AND ANNEALING OPERATIONS

Fuel and Firing

FUEL ECONOMY, Prof. William A. Bone

In a paper before the Society of Chemical Industry, Prof. William A. Bone spoke of the work of the Fuel Economy Committee of the British Association which has been appointed to consider the subject of fuel economy from a national standpoint.

The investigations are to be conducted by a committee composed of prominent representatives of the principal industrial users of fuel as well as eminent power engineers and chemists who have made a special study of gaseous fuels and combustion. The committee has resolved itself into five sub-committees, each with its own chairman, namely, Chemical and Statistical (including the chemical nature of coal and the character of the principal British coal seams); Carbonization (including gas works, coke ovens, low temperature distillation and the utilization of products derived therefrom); Power and Steam Raising (including experiments on public power schemes); Metallurgical (Iron and Steel) and Ceramic Industries; Domestic Smoke Prevention (including problems relative to domestic heating).

The writer of the paper outlines a tentative program of the work of the committee which he as chairman considered personally advisable. He says that in the first place there is a great need of further experimental research upon the chemical character of coal about which we are still very ignorant. Concurrently with such an undertaking he advises a systematic chemical survey of the principal seams in British coal fields. He considers the use of raw coal for domestic fires, steam raising and furnace work generally, a custom which from a chemical point of view cannot be defended. He further deplores the fact that out of the 20,000,000 tons of coal carbonized in the United Kingdom for hard metallurgical coke in the year

1913, no less than 6.5 million tons were treated in bee-hive ovens involving a dead loss in values of by-products of something like £2,500,000 (*Journal of the Society of Chemical Industry*, vol. 35, no. 7, p. 389, April 15, 1916, 8 pp. [paper and discussion] *g*).

Hydraulic Engineering

PIPE-LINE AT THE NEVADA WONDER MINE, J. A. Burgess

Description of an interesting pipe line installation and the automatic devices for checking interruptions to a service carried on for certain parts of the year under exceptionally difficult conditions of weather.

The pipe line takes care of a mining and milling plant in Churchill County, Nevada, where the temperature goes at times as low as — 11 deg. fahr. The installation had to deal at first with several sources of trouble which have been gradually eliminated. Clogging of the intake by leaves was taken care of by frequently cleaning the screens and having the screen area sufficiently large. A certain amount of trouble was caused by pitting of the pipe due to an excess of alkali in the soil. A protective coating applied to the pipe at the time it was laid would have prevented this deterioration, but the coating applied by the manufacturer before shipment was partly rubbed off during transportation.

The principal source of danger is excessively cold weather. To a certain extent an increase of the rate of flow can cut out ice formed in the pipe, but at temperatures as low as 4 deg. below zero the rate of flow in the line is not sufficient to prevent the formation of ice. The only way to save the pipe in such cases is to drain the line entirely. The same remedy has to be resorted to also when the creek from which the water is taken is in danger of being completely stopped by freezing.

All of this requires an ability to know at any moment the rate of flow of water in the pipe. To do this a flow indicator was devised and placed at the intake so arranged that the rate of flow could be approximately read at any telephone receiver on the system. The details of this ticker signal apparatus are shown in Fig. 3. It consists essentially of a turbine wheel just inside of the intake end of the water main by means of which the armature of a permanent magnet is periodically removed from its poles. The interruption of the magnetic flux induces an electric impulse in a coil about the magnet. The coil is grounded at one end and attached to the telephone wire at the other and each movement of the armature produces a clicking sound in the telephone receiver that is easily heard but is not sufficiently loud to interfere with conversation. The telephone line is connected with all the company telephones so that the indicator may be heard in all offices and residences. The ticker is placed in an enclosed housing and requires no attention except occasionally a few drops of oil.

Under normal conditions the ticker sounds twenty-four times per minute. If it works faster than this it indicates either a break in the line or an open drain valve. If it sounds less than that the reduction is due to decreased flow and may be caused by several circumstances. Except in freezing weather it is apt to be caused either by air or sand in the pipe or by leaves partly clogging the screens at the intake. In very cold weather it may be caused by a shortage of water in the creek or by freezing in the pipe. Only an inspection of the intake will distinguish between these possibilities and for that pur-

TABLE 1. HARDNESS OF HEATED AND SLOWLY COOLED LOW-CARBON STEEL

Temperature of Heating, Degrees Cent./Fahr.	Duration of Heating, Hours	Brinnell Hardness	Average
		97	
		101	
		98	98
		98	
		95	
	1	99	97
		94	
	2	95	95
200/392		95	
	6	98	98
		97	
	8	99	95
		90	
	1	99	95
		91	
	2	97	98
300/572		98	
	6	105	102
		98	
	8	98	100
		102	
	1	103	102
		101	
	2	103	99
500/932		95	
	6	98	96
		93	
	8	95	95
		94	

Temperature of Heating, Degrees Cent./Fahr.	Duration of Heating, Hours	Brinell Hardness	Average
	1	102	98
		93	
	2	99	97
600/1112		95	
	6	93	94
		94	
	8	93	93
		93	
	1	92	92
		92	
	2	92	92
700/1292		91	
	6	92	91
		90	
	8	92	90
		87	
	1	90	90
		89	
	2	93	91
800/1472		88	
	6	89	89
		89	
	8	93	92
		91	
	1	89	89
		88	
	2	88	89
900/1652		90	
	6	94	92
		89	
	8	83	86
		88	

Temperature of Heating, Degrees Cent./Fahr.	Duration of Heating, Hours	Brinell Hardness	Average
	1	85	87
		88	
	2	87	87
1000/1832		87	
	6	87	87
		87	
	8	91	89
		86	
	1	84	84
		83	
	2	84	84
1100/2012		84	
	6	86	84
		81	
	8	82	85
		87	
	1	88	85
		82	
	2	85	85
1200/2192		84	
	6	83	86
		79	
	8	83	81
		83	
	1	86	83
		85	
	2	86	83
1300/2372		80	
	6	81	81
		81	
	8	82	81
		79	

pose a watchman has to be kept at the head gate during the cold weather.

Another device described in the article is a warning apparatus of simple construction installed at the delivery end of the pipe line at the storage tanks (The Nevada Wonder Pipe-Line, *Western Engineering*, vol. 7, no. 5, p. 177, May 1916, 4 pp., 4 figs. *d*).

Internal Combustion Engineering

ARE OTHER CYCLES POSSIBLE FOR AUTOMOBILE ENGINES? J. Edward Schipper

One of the effects of the fuel situation has been to cause engineers to wonder if there be not some other way than the

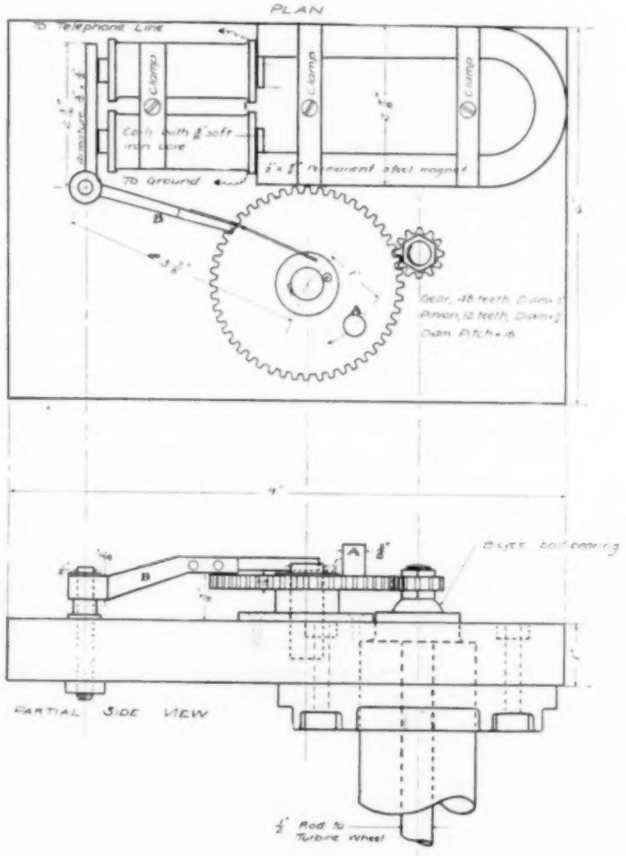

FIG. 3 TICKER SIGNAL APPARATUS FOR WATER PIPES

Otto cycle of utilizing the heat energy in liquid fuel, especially in automobiles.

A slow combustion engine with a lower grade fuel suggests heavy, slow-moving parts not adaptable to the present day automobile. What some engineers are studying now is the constant pressure cycle, with a view to determining whether or not the conditions which hold true with the lower grades of fuel render its use commercially advantageous. While under similar conditions and with the same explosive fuel the constant volume engine is more efficient than the constant pressure, it seems possible that by carrying out the expansion line of the constant pressure type, a higher efficiency may be reached particularly at reduced throttle opening. The first thought suggested by the constant pressure engine is higher compression, which does not necessarily mean an efficiency loss because practically all of the energy necessary for compression is returned in the expansion stroke. On the other hand, such an engine necessitates a constant introduction of fuel against the maximum cylinder pressure and this in turn means a receiver capable of withstanding the higher pressures. It also means the employment of a compression pump, and the question to be determined is whether or not other gains offset this. In fact, the point for practical engineers to determine is whether or not it is possible to secure the high compression ratios in satisfactory and reliable units of the size which would allow them to be used on automobiles.

The efficiency of the present day automobile engine is extremely low. With the car running at a touring speed of 15 to 18 miles per hour and the throttle open possibly less than one-third, the thermal efficiency is somewhere around 5 per cent, which means that for every dollar's worth of fuel only five cents in power is returned. There is no doubt as to our sacrificing work at the end of the stroke by cutting off the expansion line and exhausting at high pressure. In the ordinary timing diagram the exhaust valve starts to open at fully 45 deg. before lower dead center so that the pressure will have dropped to near atmospheric by the end of the stroke. On the very high speed motors the time at which the exhaust valve starts to open is much further advanced than this and the difference of a degree or two on the timing circle is quite large when the angle between the crank and 90 deg. position is less than 45 deg.

Mention has been made recently about altering the point of cut-off of the constant volume engine as a means of holding up the thermal efficiency even when operating on partial throttle opening. This has been tried by variable cam action but has not worked out satisfactorily on account of mechanical complications. Whether or not the variable cut-off constant pressure gas engine can ever be adapted to the quick-accelerating light-weight automobile, cannot be said now. It seems very possible that the answer to the whole problem lies not in compressing the combustible mixture, but rather in compressing the air only and adding the fuel by small successive charges during the stroke. This burning charge closely parallels in many of its characteristics superheated steam. If it could be introduced into the cylinder cut-off, expanded and exhausted in much the same way as steam, it would have in many respects the advantages of the steam engine without the boiler apparatus necessary for the conversion of water into steam (*The Automobile*, vol. 34, no. 16, p. 707, April 20, 1916, 4 pp., 4 figs. *g*).

Machine Shop

LIMIT GAGE PRINCIPLES AND PRACTICAL APPLICATIONS, W. H. Booth

The paper discusses the use of limit gages and tries to give a proper grasp of the purpose of their use.

The use of limit gages is essential to economical manufacturing on the interchangeable plan, especially with articles which have to be cheaply made and be entirely interchangeable. As the author points out, the limit gages are extensively used in the manufacture of munitions and a shell affords an excellent example of an article to be made as roughly as permissible and yet as good as is imperative, because, in the words of the author, "a shell is an object which in spite of its short and merry life, is used in immense numbers," and has to answer certain exact requirements.

A limit gage is not designed for the purpose of producing specially fine work, but is distinctly commercial. The term "limit" signifies the degree of departure of the work from strict accuracy permitted, and the system is based on the fact

that absolute accuracy cannot be obtained and that small departures from absolute accuracy can be worked to approximately. As absolute accuracy is very difficult and expensive to attain, practical men fix upon the amount by which any dimension may be allowed to differ from the nominal size and the piece, if properly worked to, is not so far from nominal size as the gage by which it is made. There must be no attempt to fit the piece to the "go-on" end of the gage as any such attempt increases the cost of the work needlessly and destroys the purpose of the system.

Since it is easier to vary an outside than an inside dimension, it is better to base a limit gage system on uniformity of hole than on shafts, spindles, etc., which are formed on machines like the lathe. The author discusses the matter of running fits and in this connection that of cross limits.

What makes limit gaging a success is that the parts gaged tend to average at mean sizes and by the doctrine of probability the extremes of two sets of parts do not meet.

An illustration in the article shows limit gages for various services, among them special alligator-mouthed gages and adjustable snap or caliper gages (also the Newall system). The article is apparently the first of a series (*Canadian Machinery*, vol. 15, no. 13, p. 285, March 30, 1916, 2 pp., 1 fig. *dp*).

Measuring Instruments and Measurements

INSTRUMENTS FOR RECORDING CARBON DIOXIDE IN FLUE GASES, J. F. Barkley and S. B. Flagg

The paper describes a series of tests made with several different types of recorders under service and laboratory conditions, in the course of which the following details were determined: (1) The lag in recording changes of composition of a flowing gas; (2) the accuracy of each type of recorder; (3) the variable factors affecting the operation and accuracy of each type; (4) the repairs and renewals necessary; (5) the kind and amount of attention required. The purpose of the Bureau of Mines in publishing the results is to show the factors which may affect the accuracy of a carbon dioxide recorder and the manner in which the recorder should be tested.

Seven instruments were tested, three English, two American, one German and one Swiss. The paper gives a detailed description of each apparatus and results of tests obtained with it, and, further, gives useful hints as to installing the gas line and sampling pipe for any instruments (Department of the Interior, Bureau of Mines, *Bulletin 91*, Washington, 1916, 52 pages of text and an index of 2 pp., 25 figs. *eA*).

SOURCES OF ERROR IN CRADLE DYNAMOMETER TESTS, M. Le Pen and J. Villey

The paper discusses the various sources of error which are apt to affect the measurement of the power developed by internal combustion engines on the testing stand in cradle dynamometer tests.

The principle of the measurement on the testing stand is as follows: The braking is effected by means of a fan or propeller set on the engine shaft. The engine itself is bolted to a frame which is given the freedom to oscillate about an axis parallel to the engine shaft. In order to maintain this frame in equilibrium, notwithstanding the reaction of the air on the propeller, a suitable weight P is located on a horizontal arm forming part of the frame. This arm is normal to the axis of oscillation, and the weight is at some desired distance l from the vertical plane of the axis of oscillation. If ω is the angular velocity of the propeller, the power W of the engine is determined from the formula $W = Pl\omega$. The exact formula is really $W = C\omega$ where C is the average moment *with respect to the engine shaft* of the braking forces exerted by the air, and the equation $C = Pl$, implicitly admitted as being the expression of equilibrium of the testing stand, may be actually lacking in exactness for various reasons.

In the first place, other forces may intervene in addition to those considered in this equation. These forces are the reactions of the exhaust with respect to the external air. Unless they are symmetrically distributed with respect to the vertical plane of the axis of oscillation, or unless their directions are in a plane passing through this axis, these reactions will affect the equilibrium, especially if the test is carried on with a tractor propeller utilized to cool the engine. On the other hand, even assuming that all precautions have been taken to eliminate the action of these parasite forces and their average moment with respect to the axis of oscillation, there still remains another source of error which may become very important in certain cases.

One must not confuse the axis of the engine shaft and the axis of oscillation of the testing stand, practical considerations making it advisable to locate one above the other at a distance h usually of several decimeters (1 dm = 3.937 in.). If the braking forces exerted by the air were at all times reduced to a couple, their average moment would have the same value C with respect to the axis of oscillation as with respect to the engine shaft which is parallel to it. If it is not so, they have to be equivalent at every instant to a couple, the average moment of which will still be equal to C plus the force f which has its point of application on the engine shaft. This force, f, which in magnitude and direction is a function of the azimuth ωt of the propeller, does not affect the consumption of the power produced because its point of application remains fixed, but by being transmitted by the shaft to the bearings, it affects the equilibrium of the testing stand by its moment $fh \cos \omega t$, in the same manner as a weight affects its lever. The average geometrical value of its moment is determined by a lack of symmetry of the resistances encountered by the blades of the propeller all along their circular trajectory.

The proximity of the ground and the testing stand itself create inequalities of this character which would be, strictly speaking, absent only in the case when all the obstacles encountered by the streams of air had a symmetry of revolution around the axis of the propeller. If the propeller rotates inside a large casing constituting in this way an air turbine (this arrangement is sometimes used to avoid the throwing around of oil) the lack of symmetry becomes particularly pronounced because in its materially uniform circular movement each blade when it approaches the tangential exhaust port attacks the surrounding air with a relatively decreasing velocity. Measurements carried out under such conditions on engines from 80 to 110 h.p. have shown errors as high as 20 per cent. Air currents also cause difficulties of this kind. The author states, however, that all these sources of error may be reduced to very small amounts by certain manipulations and that this method of testing agents is a very convenient process of particular advantage where it is desirable to determine from the oscillations obtained the slightest instantaneous variations of the motor couple (*Sur la mesure de la puissance des moteurs au banc-balance*, Maurice Le Pen and Jean Villey, *Comptes rendus des séances de l'Académie des Sciences*, vol. 162, no. 11, p. 383, March 13, 1916, 2 pp. *eA*).

THE FAN DYNAMOMETER, J. Lawrence Hodgson

The article gives data of some tests made with a fan dynamometer. The investigation was undertaken in order to obtain a more accurate knowledge as to how the resisting torque due to the blades of a fan dynamometer varies with their shape and size, with the diameter of the fan and with the density of the fluid in which the blades rotate.

The blades used were ½ in., 1 in. and 2 in. square and ½ in., 1 in. and 2 in. in diameter. All the tests were carried out with the fan rotating in water with the exception of one test which was taken with the fan rotating in air. In the water tests the vertical spindle carrying the fan was rotated in a covered tank of still water 20 ft. square and 5 ft. deep. The plane of the fan arm was 10 in. below the surface of the water, the coefficient of resistance having been found to be constant for the largest diameter of fan used for all depths of immersion greater than 6 in.

A separate series of tests established the fact that the torque due to the arms (μ_a) was given with sufficient accuracy by the formula:

$$\mu_a = 0.35 \times 10^{-5} \sigma N^2 r_a^4 t W \qquad [1]$$

See notation at end of the abstract.

The resisting torque (μ_b) due to the blades alone was assumed to be given by the equation

$$\mu_b = K N^2 r^3 S^5 W \qquad [2]$$

where K is coefficient which varies with the ratio r/s and with the shape of the blades which is constant for similar fans. The article reproduces a curve showing the value of K plotted against the ratio r/s as determined from the experimental results. When r/s is large, K approaches a constant value for each shape of blade. The limiting value of K for the circular blades is about 0.7854 times less than that for the square blades. A point is shown on the curve of values of K obtained from 1 in. blades in air which agrees almost exactly with the value of K obtained by rotating the same blades in water.

The horsepower absorbed by any fan can be readily calculated by substituting the value of K as given by the curves in the original article in the equations tabulated at the end of the abstract.

In fan brake dynamometers, it is customary to make the value of r/s small. The present tests show, however, that the experimental accuracy is least for the small values of r/s. Further the shape of the K-r/s curve is more easily defined from the theoretical considerations when the ratio of r/s is large and for these reasons, it is preferable to design the fans so that the ratio r/s is not less than 2.5 or 3. Round blades are to be preferred because they require no special care in alinement when being fitted to the arms.

The author gives further the following equations

$$\mu = \mu_a + \mu_b \qquad [3]$$

where μ_a and μ_b are given respectively by equations [1] and [2] above.

$$\text{H.P.} = \frac{\mu N}{63{,}000} \qquad [4]$$

In all of these equations the following notations is used:

W = Density of the fluid in which the fan rotates in lb. per cu. ft.
= 62.33 for water at 50 deg. fahr.
= 2.7 p/T for air.
μ_a = Torque due to arms alone in inch-pounds.
μ_b = Torque due to blades alone in inch-pounds.
μ = Total torque in inch-pounds.
N = Rev. per min.
S = Length of side of square blade, or diameter of circular blade in inches.
r = External radius of the fan in inches.
r_a = Radius of arms in inches.
t = Thickness of arms in inches.
K = Coefficient depending upon the value of r/s and the shape of the blade.
σ = Coefficient depending on the section of the arms.

(*The Aeronautical Journal*, vol. 20, no. 77, p. 20, January-March, 1916, 6 pp., 4 figs. *e*).

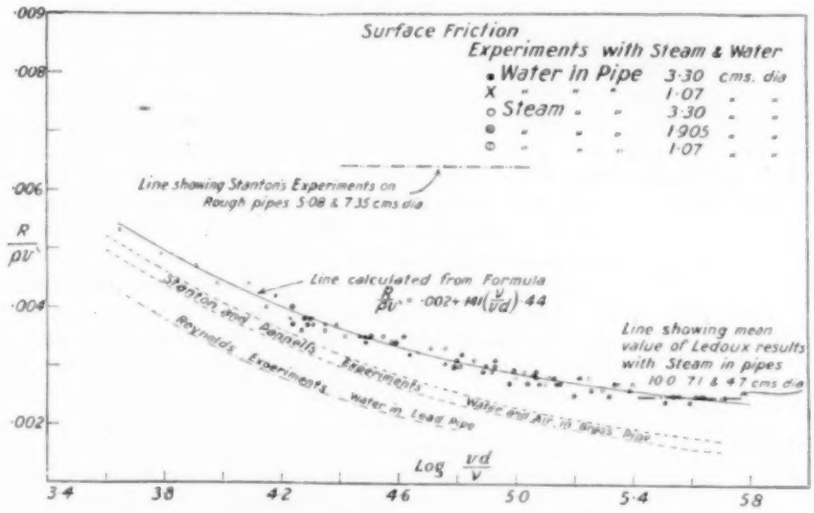
Surface Friction
Experiments with Steam & Water
• Water in Pipe 3·30 cms. dia
X " " " 1·07 " "
○ Steam " " 3·30 " "
● " " " 1·905 " "
○ " " " 1·07 " "
Line showing Stanton's Experiments on Rough pipes 5·08 & 7·35 cms dia
Line calculated from Formula
Line showing mean value of Ledoux results with Steam in pipes 10·0 7·1 & 4·7 cms dia
Stanton and Pannells Experiments
Reynold's Experiments, Water in Lead Pipe
·009
·008
·006
·004
·002
3·4
3·8
4·2
4·6
5·0
5·4
5·8

FIG. 4 CURVES OF SURFACE FRICTION FROM EXPERIMENTS WITH STEAM AND WATER

Physics

SURFACE FRICTION: EXPERIMENTS WITH STEAM AND WATER IN PIPES, Cecil H. Lander

The article discusses various equations for the flow of steam and water in pipes with particular reference to phenomena of surface friction, and describes some new experiments in the same line.

The article gives a brief summary of previous work, especially that of Osborne Reynolds, Lord Rayleigh, and Stanton and Pannell (compare THE JOURNAL, 1915, p. 242).

The object of the present research was in the first place to obtain accurate data for the resistance to flow in pipes conveying steam and other vapors with a view to checking the accuracy with which Osborne Reynolds' dimensional law of flow could be made to represent the friction of these fluids. Next, the work was extended to ranges over which this law did not accurately apply and the results have been used to extend the work of Stanton and Pannell to the case of friction between steam and metal surfaces.

In the present research, the moving fluid was in most cases either dry saturated or slightly wet steam and the experimental range of velocities extended usually to 4000 cm per sec., although in a few experiments a velocity of 6000 cm per sec.

was obtained. Higher speeds were not used since extremely high speeds such as can be obtained easily with steam are associated with superheating down the pipe, making the reduction of the results obtained too complicated and unreliable. In all pipes the values of the resistance corresponding to low velocities of steam were obtained, although the work becomes increasingly difficult as the velocity decreases, and eventually reliable results become impossible owing to the serious effects of condensation.

The author describes in detail the experimental apparatus used. Steam was obtained from a large separator and a 300 h.p. Babcock & Wilcox boiler, the large capacity of the boiler rendering it easy to maintain steady pressure conditions during the trials.

The methods of reduction of the experimental values are reported in the original article in detail, the results themselves being given in the form of tables and for comparison with other experimentals in the form of curves.

In Fig. 4 the values of all the experimental results have been plotted with $R/\rho v^2$ as ordinates and log vd/ν as abscissae, where R = resistance per unit area, ρ = density of the fluid, v = velocity, d = diameter of the pipe, ν = kinematical viscosity of the fluid, all in metric units. The mean results as calculated from the formulae of Ledoux for their steam velocity are also plotted on the diagram. The resistance for the artificially roughened pipes in the Stanton experiments (horizontal line) is expressed by the formula

$$R = 4.6\, v_c^2 \times 10^{-6}$$

where v_c is the velocity at the axis. From the curve in Stanton's paper giving the radial distribution of velocity in these pipes the value of the mean velocity has been determined, the horizontal line representing the resistance in the screwed pipes reduced to terms of the mean velocity.

The author's points for steam lie with fair accuracy upon a smooth curve slightly higher than Stanton and Pannell's boundary curves for low values of vd/ν, but become proportionally higher for large values.

The author calls attention to the fact that, as has been shown by Lees, Stanton and Pannell's experiments can be represented with considerable accuracy by an expression of form

$$R = \rho v^2 \left\{ a + b\,(\nu/vd)^n \right\}$$

the constants for air and water in smooth brass pipes being $a = 0.0009$, $b = 0.0763$, and $n = 0.35$. With a modification of the constants the same expression represents the mean of the present experiments, the line in the figure having been plotted using the following values: $a = 0.002$, $b = 0.141$, and $n = 0.44$. From the general trend of their curves for high values of vd/ν, Stanton and Pannell predicted a limit beyond which the resistance would be constant and hence independent of vd/ν. This is equivalent to the resistance varying as the square of the velocity. In the steam curves owing probably to the pipes being slightly rougher, this limit would appear to be reached earlier, and the ultimate value of $R/\rho v^2$ to be considerably above that corresponding to the smooth pipes used by Stanton and Pannell. Beyond a certain limiting value of vd/ν the resistance varies as the velocity squared becomes less with the roughness of the pipe surface, until for a very rough surface the resistance varies as the velocity squared for values only exceeding by small amounts that corresponding to the critical velocity.

The present experiments are of interest because further direct evidence has been produced to demonstrate the truth of the dimensional law which has been now shown experimentally to extend to the case of saturated vapors. Further, in the present experiments a range of pressures was used for the first time extending from about 15 in. of vacuum to 200 lb. per sq. in. above atmosphere. The law of dynamical similarity has been further demonstrated. The present work, by demonstrating the truth of the law as applied to the flow of steam and water in pipes, opens up the possibility of inferring the resistance of complicated steam passages such as are met with in turbines, by tests and models according to the law of similarity. (*Proceedings of the Royal Society*, Series A, vol. 92, no. A. 640, p. 337, April 1, 1916. 17 pp., 3 figs. *etA*).

THE COMPRESSIBILITY OF NATURAL GAS AT HIGH PRESSURES

G. A. Burrell and I. W. Robertson

The paper treats of an investigation of the compressibility, at pressures up to 35.5 atmospheres, of the natural gas supplied to the city of Pittsburgh. The results are of practical value because in measuring natural gas it is the practice to assume that the product of the pressure by the volume is a constant.

Actually it has been found that the compressibility of the natural gas of Pittsburgh differs from that of an ideal gas, the deviation amounting to as much as 15 per cent at a pressure of 35.5 atmospheres. In actual practice natural gas is sometimes measured at pressures as high as 600 lb. per sq. in. and many millions of cubic feet are measured at pressures of 20 to 30 atmospheres (300 to 450 lb. per sq. in.). Hence errors of great magnitude are introduced into the measurement. For instance, suppose 100,000,000 cu. ft. of gas a day is measured at 25.6 atmospheres: according to the data found in this investigation, the gas is 11 per cent more compressible at this pressure than at atmospheric pressure, or each day 11,000,000 more cubic feet of gas is measured than is supposed. If no correction is applied in measuring the gas a distributing company that buys natural gas at high pressure and sells it at low pressure may sell much more gas than it pays for. (Department of the Interior, Bureau of Mines. *Technical Paper 131*, Petroleum Technology 31, Washington, 1916, 12 pp., 2 figs. *e*).

TURBULENT FLOW IN PIPES AND CHANNELS.

Professor L. V. King

The present publication is apparently only part of a paper covering the subject of turbulence, and presents only the theory relating to the establishment of turbulent flow in pipes and channels.

The author gives at the outset an historical survey of the development of the theory of viscosity, and from this proceeds to a consideration of actual flow under comparatively simple experimental conditions. He treats first of a steady flow between two parellel planes and gives an equation for total flow per unit breadth and mean velocity of flow. He considers this simple case of steady motion of interest as it has been made the starting point of some theoretical treatments of the stability of laminar motion, but as far as he is aware no experiments have been carried out with a disposition of apparatus corresponding to this solution. He himself has, however, made a detailed experimental investigation of gaseous viscosity by an actual examination of the gradients of velocities themselves; and the results obtained indicate, as he states, the somewhat surprising conclusion that the parabolic distribution calculated from the usual viscous fluid theory is only a rough approximation to a much more complicated state of affairs.

He investigates next the steady motion in a pipe of *circular cross-section*, and again gives equations for the total flow and mean velocity over the cross-section. It is generally assumed that the theory of viscosity obtains its application to reality, in that the equation for the total flow obtained in this case contains all the laws found experimentally by Poiseuille, but actually a marked deviation is easily noticeable as soon as the diameters exceed a few millimeters, even at velocities considerably below what is taken to represent the critical velocity.

Shearing motion between parallel planes is dealt with next, the author giving an equation for the sheering stress F between the planes per unit area. The measure of F obtained experimentally, as well as the fundamental law of viscosity in these circumstances, relates, however, to the traction between the fluid and a solid boundary, and not to the traction between layers of fluid. The measurement is here extremely difficult, and Gilchrist points out that small discrepancies of about 0.5 of one per cent exist in the determination of the coefficient of viscosity by the various methods employed, and that these cannot be attributed to errors of experiments. Hitherto direct measurements of velocity-gradients did not appear to have been carried out, although this is now possible owing to the development of the linear hot-wire anemometer described in a previous paper by the author.

The second part of the paper treats of the stability of laminar flow in pipes and channels. It likewise opens with an historical and critical survey of the theoretical development, with particular reference to the work of Osborne Reynolds, Kelvin and Rayleigh. The author calls attention to the fact that the most recent theoretical treatment of the subject (by Hopf) tends to confirm the original conclusions as to the stability of a state of steady motion. The unsatisfactory state of knowledge on the subject at the present time is, however, clearly shown from a table of theoretical and experimental values of Reynolds' Constant K, which differ very markedly both from each other and from the generally accepted values obtained for liquids and gases.

The experimental data, however, refer to tubes of circular cross-section, whereas the simplest theoretical case refers to the flow of liquid between parallel planes on which no observations have hitherto been available. The author has, though, made a series of experiments on the flow of air, and the results indicate the existence of hitherto unsuspected conditions of laminar flow at extremely low velocities, as well as at velocities considerably higher than those which are taken to represent, according to usual interpretation, critical velocities.

By means of the linear hot-wire anemometer, developed by the author, the velocity distribution over the cross-section of a two-dimensional channel (section 0.45 cm. by 5.08 cm.) was measured for various pressure differences. Owing to the high resolving power of the instrument, it was found possible to measure velocities at intervals of 0.05 mm. over the cross-section, and in this way a velocity distribution curve representing as many as 100 observations could be obtained, the pressure difference under which the flow took place being maintained constant to 1-10 of one per cent. Even at velocities considerably below the critical velocity as usually defined, the distribution curves showed consistent and interesting deviations from the parabolic form demanded by theory: (1) The experimental curves develop well marked "humps" in the neighborhood of planes midway between those dividing the distance between the walls of the channel in equidistant parts. With increasing velocities the number of "humps" increases. (2) Although the general shape of the distribution curve is parabolic, the maximum falls very much below that demanded by the theoretical viscous flow theory, as though some factor contributed to increase very materially the ordinary kinetic theory coefficient of viscosity denoted below μ_o.

The writer explains both of the above peculiarities by the influence of transverse stationary sound waves. When the flow of a *compressible* fluid takes place under conditions which permit of the establishment of stationary modes of sound vibrations, the wave front is refracted by the velocity-gradients which exist in the medium. As rate of change of momentum is propagated along a sound ray, it follows that under these conditions the existence of compressional vibrations will result in a component of rate of change of momentum proportional to the velocity-gradient being transferred across an element of surface parallel to the direction of the flow; hence the author gives for viscosity a formula, $\mu = \mu_o + \mu_s$, defining it as the sum of μ_o, the ordinary viscosity of the kinetic theory plus μ_s, a "quasi-viscosity" due to the existence of compressional waves and proportional to the *intensity* of the wave motion. The writer believes that in the combination of compressional vibrations and shearing motion lies the origin of a vortex rotation which, as the amplitudes of the sound vibrations and their frequencies increase, may ultimately result in the formation of *finite* vortex filaments resulting finally in "turbulent motion" in the generally accepted sense of the word. The fact that the factor of compressibility appears to be of considerable importance in determining the conditions of the stability of laminar flow causes the various theoretical treatments, including those of Reynolds, Rayleigh, Kelvin, Sharpe and Orr, to lose a certain part of their value.

The author believes that still another factor may play a part in determining the instability of flow in tubes and channels, and that is the *determinateness* of the various transverse modes of sound vibrations which may be set up. In a two-dimensional channel (or channel of elongated cross-section), the nodes and loops are extremely determinate in position, and one should expect laminar flow to persist to very high velocities. In the case of a tube of circular cross-section, however, some of the normal transverse modes (e.g. those having diameters as nodes) are indeterminate in position, and in an actual case would be determined by accidental inequalities on the interior of the tube or by slight departures from circular form. It would appear that in such cases Reynolds' criterion of "sinuous" motion would be decided not by instability of steady flow in the usual sense, but by the appearance of the first transverse mode having a diametrial node. Relatively to the fluid these indeterminate modes would tend to twist around, resulting in a state of affairs which, if continued long enough, would, in spite of the stabilizing effect of viscosity, result in a complete destruction of conditions of steady flow. While the effect of the material of the tube on the critical velocity observed by several experimenters is probably largely due to the degree of mechanical finish of the interior surface, it would also seem that the acoustic properties of the walls of the tube or channel may not be without influence on the velocity gradients in the immediate neighborhood of the boundary. In the flow in tubes of large diameter, the velocity distribution over a particular cross-section is nearly always unsymmetrical with respect to the axis. (*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, vol. 31, no. 184, p. 322, April 1916, 17 pp., *et A.*)

VIBRATORY WHIRLS IN AIR, Sylvain Périssé

This paper refers to experiments on and the theory of the formation of vibratory vortices in air due to the motion of a blade wheel with the blades disposed longitudinally through the axis of rotation. It presents the conclusions reached by Charles Weyher and was read before the French Society of Civil Engineers on February 21.

For the purpose of the first series of experiments a wheel was used with longitudinal blades 0.30 m (11.8 in.) long and 0.05 m (1.96 in.) in diameter. The paper describes in detail the efforts by which the air streams were made visible.

It has been found that two kinds of air streams are formed —first, helicoidal centrifugal spires, going from the equator of the rotating sphere to each pole; and second, helicoidal centripetal spires going from the poles to the equator. When a blade wheel having a vertical axis was made to rotate over a reservoir containing water, heated so that it would evolve steam, it was found that the steam lines which rotate, at first slowly, around the vertical axis, suddenly assemble in spirals which form a spindle-shaped body with very clear delineations; this steam figure remains in equlibrium under the influence of the centrifugal forces which try to force it downwards on one hand and the centripetal forces which attract it towards the equator of the rotating wheel on the other. In this way the author has succeeded in reproducing a tornado at sea or a cyclone with its peculiar calm region in the center, and fall of barometric pressure.

A second series of experiments similar to those described above were carried out with a rotating sphere made up of circular blades located along the axis of the sphere and together forming a rigid structure capable of rotating about its axis. Here again the same air whirls were observed, asymmetrical with respect to the plane of the equator; the same intercrossing streams of air were found present, and centrifugal streams increasing in diameter but progressively decreasing in velocity while the centripetal streams increased in velocity as they came nearer to the central vacuum.

When the author placed on a needle point a little blade wheel and brought it near the rotating sphere, he found that this test wheel rotated in one direction on one side of the plane of the equator of the sphere, and in an opposite direction on the other side.

A very interesting series of experiments were tried out by means of a rotating sphere located in a room 4 to 5 m (13 to 16 ft.) on each side and 4 m (13 ft.) high. The room was devoid of furniture, and protected from air currents from the outside; the sphere was placed half way to the ceiling on an axis inclined 45 degrees and rigidly held as shown in Figure 5. The following facts have been observed:

All the bodies which happen to be in the room appear to be connected to the moving sphere through the intermediary of air streams which ceaselessly leave the sphere and return to it, these streams twisting around all these objects and acting on them by forming local whirls about them.

The figure shows a number of little balloons; all of them are in little groups and each is vibrating all the time. When the balloons are forced apart, they rapidly come back again, but if the group of balloons is brought up closely to the rotating sphere, they separate to all sides as shown by *A*. The four balloons left on the floor fall against each other without touching one another; inside of the external whirl there are several local whirls and the four little balloons behave like the molecules of a single body.

The paper describes in some detail experiments made to determine the properties of attraction and repulsion of aerial whirls as compared with magnetic bodies. It was found that when two blade wheels rotate in opposite directions, they tend to attract one another because with the air streams of the whirl form moving in the same direction between the blade wheels the air tends to become rarified between them and the external pressure makes them come together. If, however, the wheels rotate in the same direction, the opposite takes place and the tendency is for the wheels to repel one another. Next, a little fan wheel was located on an extension of the axis of a vertical wheel and arranged in such a manner that it should be either free or not free to rotate about its axis, but have all the time a freedom of vertical displacement. It was found that, notwithstanding the attraction due to the centripetal streams of the whirl formed by the rotation of the main wheel, the little wheel will not move if it be prevented from rotating, but as soon as it has restored its liberty to rotate about its axis, it will be attracted into the vortex: it will glide until it reaches the top of its axis and will acquire a motion of rotation which it will indefinitely conserve, even becoming in itself a center of a vortex capable of attracting other small wheels of a similar nature.

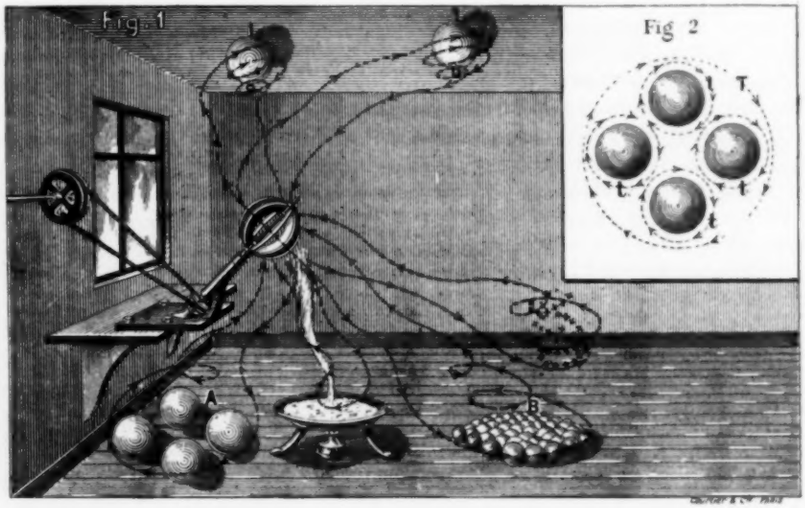

FIG. 5 ARRANGEMENT FOR PRODUCING VORTICULAR MOTION IN AIR

If fine sawdust be thrown on a screen located about a horizontal wheel, one can seen how the particles form an ellipse about the center of the wheel and one can see further how they are repelled from the center towards the two poles. In the course of time this ellipse gradually transforms into a circle about the same center.

From these experiments Weyher comes to the conclusion that the mechanism of vorticular motion is as follows: The gas does not simply rotate in a single path about its axis, but is broken up into an infinite number of streams separate from one another; each of these streams describes helicoidal screw paths, some having a right hand and some a left hand thread, some centripetal and others centrifugal. This amounts to

saying that the air streams cross one another on through the space, moving in opposite directions and mutually avoiding each other, but producing as many vibrations as there are crossings of paths, i. e., an infinite number.

An interesting experiment makes it appear very likely that this particular mechanism actually applies to the case of ether. If an air whirl be made to act upon very fine dust or very light flakes of some material and if proper arrangements have been made, one can see how, through the inter-crossing of the centripetal and centrifugal spires, the dust or flakes form a transparent ellipsoid. This ellipsoid may even be held suspended by maintaining an equilibrium between the suction (attraction) of the rotating sphere with its vertical axis on one hand and the force of gravity which tries to pull it down on the other hand.

almost exclusively to the heavy simple non-articulated engines of the Mikado and Santa Fé types. At the present time it appears to be regaining a portion of its former favor and bids fair to be returned on a larger scale than before with the satisfactory solution of the intercepting valve difficulty.

Recently 15 Mallet type engines built by the Lima Locomotive Corporation for the Western Maryland R.R. have been provided with a form of valve which is not only claimed to meet the requirements of the conditions spoken of above but is unique in other respects. It has a novel form and position of the valve which serves both of the high pressure cylinders alike and which, being placed in a detachable casing in a transverse position on the front face of the high pressure cylinder saddle, makes possible the casting of both high pressure cylinders from the same pattern. The valve proper has but

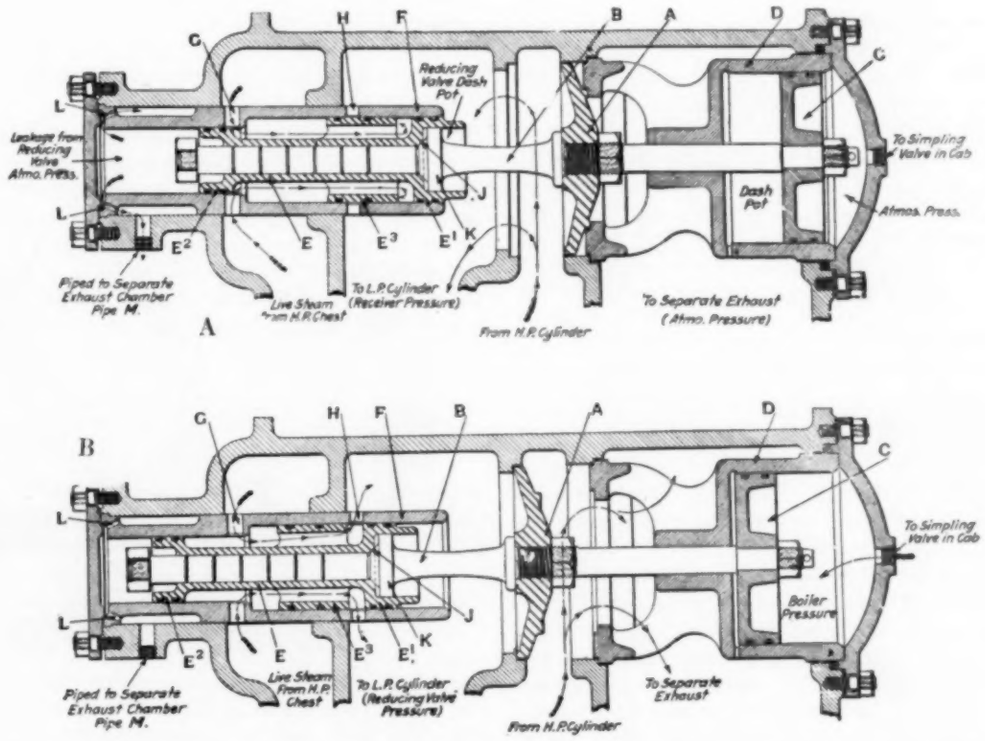

FIG. 6 SIMPLEX COMPOUNDING SYSTEM FOR MALLET LOCOMOTIVES: A, INTERCEPTING VALVE IN COMPOUND POSITION; B, INTERCEPTING VALVE IN SIMPLE POSITION

The paper contains also interesting applications of the work of Weyher to the problems of physics of ether and wireless telegraphy made by the author of the paper, Sylvain Périssé (*Les tourbillons vibratoires*, F. D. *Le Génie Civil*, vol. 68, no. 15, p. 233, April 8, 1916, 3 pp., 4 figs. *e*).

Railway Engineering

THE SIMPLEX SYSTEM OF COMPOUNDING FOR MALLET LOCOMOTIVES

While the use of intercepting valves on Mallet locomotives for the purpose of enabling the application of high-pressure steam in the low-pressure cylinders when necessary has been quite extensive, the gain that has accrued through this means has so far been discounted through the expense and trouble involved with the complicated forms of valves that have been used for this purpose.

For some time of late the Mallet type of engine gave way

two moving parts, the construction is entirely symmetrical about the axis of the valve stem and the valve itself is fully accessible. Figs. 6A and B illustrate the design of the valve. The casing is divided into four separate chambers called respectively, beginning at the right-hand side of the engine (left side of drawing) live steam chamber, receiver chamber, high pressure exhaust passage, and separate exhaust chamber. In the operation of the valve, steam from the high pressure cylinders is controlled by the main valve *A* causing it to flow into the receiver chamber and thence to the low pressure cylinders when the engine is working compound, Fig. A, and into the separate exhaust chamber when working simple, Fig. B. Stem *B* of the intercepting valve on which the main valve *A* is secured is continued toward the left-hand side of the engine and has fixed to this end a piston *C* which works in a cylinder *D*. Live steam is admitted to the outer face of this piston when the simpling valve in the cab is placed in "simple" po-

sition forcing the main valve into the position shown by Fig. B. The inner face of this piston, by trapping air between it and the bottom of the cylinder *D*, forms a dash pot to prevent slamming. On the continuation of the stem *B* is a sliding reducing valve *E* which has a movement of 1½ in. on the stem as well as a traverse of 3 in. with the main valve. This valve has three functions. *First*, to admit steam at reduced pressure to the receiver chamber when working simple, *second*, to force the main valve into compound position when pressure is released from the piston *C* and, *third*, to cut off the supply of live steam to the receiver when working compound.

The separate exhaust pipe which is a feature of this system communicates with an annular removable nozzle surrounding the main nozzle, the control of the power exerted by the high pressure cylinders when working simple being effected by the changing of this nozzle. The smaller the nozzle the greater the back pressure acting on the high pressure pistons. This reacts on the reducing valve and adds power to the low pressure cylinders. Thus a perfect balance of work in simple operation is effected. Back pressure in the separate exhaust chamber cannot unbalance the intercepting valve or cause it to flutter.

An interesting feature is that it is possible to operate the engine, though with reduced tonnage, even with the intercepting valve removed. Hence an intercepting valve failure cannot cause a complete engine failure which is of importance when breaking in new power (*Railway Review*, vol. 58, no. 18, p. 603, April 29, 1916, 3 pp., 4 figs. *d*).

Steam Engineering

STEAM PLANT EFFICIENCY, Vernon Smith

A paper of interest, in that it gives expression to the modern views of steam power engineers in England.

The author first takes up the competition between Lancashire and water-tube boilers. He holds that where large units are desirable and where ground space is of consequence, the water-tube boiler is the proper type to install; but apart from this there does not appear to be much to justify the claim that it is a better and more efficient boiler than the Lancashire unless it be that steam can be raised quicker with a water-tube boiler when being set to work after cleaning than with the Lancashire boiler. The efficiency of an ordinary hand-fired Lancashire boiler is lower than that of a water-tube boiler working under similar conditions, but in plants equipped with suitable accessories the efficiencies are nearly the same.

Two serious impediments regarding the Lancashire boiler as it is generally worked today which seriously affect its efficiency are improper design of the furnace and the fact that it is too often hand-fired.

In order that the furnace may be efficient, the temperature should be as high as possible, and sufficient time must be allowed for complete combustion, hence a large combustion chamber built with the best quality fire-brick. On the other hand, when the gases pass from the grate of a Lancashire boiler they immediately impinge on a comparatively cold plate which reduces their temperature and allows the unburned carbon to pass off as soot. This is particularly the case where cross-tubes are fitted in the boiler flues, and with the Galloway boiler it is almost impossible to obtain smokeless results.

Too much attention has been paid to the back end of Lancashire boilers at the expense of the furnace, and reduction in temperature of the flue gases at the flue exit appear to be the chief aim. Economizers, air heaters and superheaters have been installed, and when the gases, prior to entering the chimney, have been reduced to about 350 deg. fahr., it has been considered that maximum efficiency has been attained. This is not the case so long as the old-fashioned furnace is used, which can be considered to a degree to act as a condenser. Just because the temperature of the gases at the rear of the so-called "economic type boiler" is as low as those at the rear of a water-tube boiler, the former does not become essentially as efficient as the latter because the range of temperature itself is not so great.

As an improvement on this type of boiler the author suggests a system of proper baffling which even might be carried into the side flues and operated by means of levers (Fig. 7). Of course, this baffling, the purpose of which is to increase the velocity of the gases, will require a more powerful draft.

The boiler proper should be used only as an evaporator to impart only latent heat to the steam. Live steam feed-water heaters do contribute to an increase of efficiency, in addition to which they tend to increase the evaporative capacity of the boiler and in the case of Lancashire boilers tend to minimize the strains, owing to the large body of water this type of boiler carries.

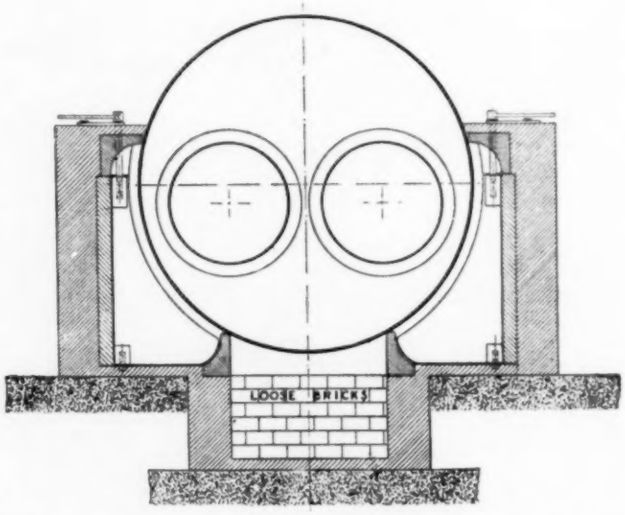

FIG. 7 SUGGESTED DESIGN FOR INCREASING VELOCITY OF THE GASES

The author appears to be in favor of the "dished end" type of construction and, among other illustrations, shows a dished end Lancashire boiler fitted with corrugated flues throughout (Cp. bibliography at end of the Engineering Survey section). (*Proceedings of the South Wales Institute of Engineers*, vol. 32, no. 1, p. 45, March 21, 1916, 39 pp., 13 figs. *dp*).

Thermodynamics

THE FUNCTIONAL RELATION BETWEEN THE THOMSON-JOULE EFFECT FOR AIR, AND PRESSURE AND TEMPERATURE, AT PRESSURES UP TO 150 ATMOSPHERES, AND TEMPERATURES FROM −55 DEG. TO +250 DEG. CENT., F. Noell.

An extensive experimental investigation of the subject. The author comes to the conclusion that the experiments carried out do fully establish the manner in which the Thomson-Joule effect is affected by pressure and temperature within the limits indicated above.

From the results of the experiments he derives the following formula:

$$\Delta = \frac{dT}{dp} = \frac{A_1 - A_2 p}{T} + \frac{B_1 - B_2 p}{T^2} + \frac{C_1 - C_2 p}{T^3} + D_1 - D_2 p$$

where Δ is the cooling for a fall of pressure of 1 atmosphere;

T absolute temperature of the gases on the high-pressure side;

p arithmetic means of pressures on the high and low pressure sides;

dp difference in pressure between the high and low pressure sides;

dT corresponding differences in temperature;

$A_1, A_2, B_1, B_2, C_1, C_2, D_1, D_2$ are constants.

He found that at all temperatures there occurs a linear decrease of the cooling effect with the pressure.

By means of integration was found from the experimental results the fall of temperature due to the action of throttling from a high initial pressure down to one atmosphere; this fall of pressure was calculated and plotted as a curve; the latter shows that the proportionality between the cooling and the pressure difference does not hold at low temperatures and high pressures.

From the observed cooling effect was determined, for the region of tests, the specific heat of air c_p, this having been done on the basis of the values of Scheel and Heuse, and Swann for one atmosphere (*Die Abhängigkeit des Thomson-Joule Effektes für Luft von Druck und Temperatur bei Drücken bis 150 at und Temperaturen von — 55° bis + 250° C.*, Dr.-Ing. Friedrich Noell, *Forschungsarbeiten auf dem Gebiete des Ingenieurwesens*, no. 184, Berlin, 1916, 46 pp., 17 figs. *e*).

Varia

OXY-ACETYLENE WELDING OF STEEL TUBING, Charles C. Lynde

Description of a process of manufacture of steel tubing by means of oxy-acetylene welding as used by the Elyria Iron & Steel Company, of Cleveland.

The tubing produced ranges from ½ in. up to 4 in., and is made mostly from cold-rolled steel of from 16 to 20 gage. The steel passes from the reels through a felt cleaner which takes off grit and other substances that might injure the rolls or interfere with the welding of the steel. The strip first enters the forming rolls, where it is formed into the shape of a very extended W. The following rolls push down the middle hump of the W and force the steel into a circular tube with sufficient spring to make it retain its position even without the aid of the forming vise used for welding. As the tube springs into shape after the final rolling it is seized by the revolving jaws of the welding vise and held in shape while passing under the welding torch and until the weld sets. The torch consists of five flames arranged to operate axially on the tube passing under it and generate sufficient heat to weld the tube thoroughly. The dies which hold the stock during its transit under the blow-pipe are made in sections and revolve around a water-cooled chamber which prevents the heat absorbed from the oxy-acetylene flame from heating them to a temperature high enough to draw the temper. These jaw sections fit closely around the tube except for a slight notch around the top where access is given for the flame. After emerging from the welding dies the tube is drawn under a grinder to remove any burrs resulting from the welding operation and then enters the sizing rolls and thence into the pulling dies. These dies are held up against the tubing by pressure plates and are driven through the pulleys or sheaves over which they pass. The tubing is next passed through a set of straightening rolls and then cut to length by an automatic cutting device which rides with the tube during the time required for the cutting operation.

Each machine is provided with individual motor drive and a small countershaft system is carried over the various moving sections to give the most direct drive possible without interference by the belts.

For tubes slightly less in diameter than can be produced by the welding machine the tubing is fed through a swaging machine and the diameter brought to the proper limits. The swaging machine is water cooled.

A drainage pit is located under the welding machine to serve as a catch basin for the water used for cooling the welding dies and for clearing away the grinding grit. Under the swaging machines there is also a ditch cut through the floor for the installation of a drain for the cooling water. The article points out in this connection the advantage of wood block flooring. The machine was first set up without any provision for cooling the swaging dies. Experience, however, demonstrated the need for cooling, so a row of blocks was pulled up to give a buried drain without the trouble and work which would have been attendant upon putting such a break in a concrete floor. The blocks removed can be cut down and replaced over the pipe without interfering with the shop work and without leaving an obstruction to trucking.

The article describes in considerable detail the method used for generating and storing the gas (*Steel and Iron*, April 1916, p. 109, 6 pp., 4 figs. *d*).

CHARTS

RELATION OF PRESSURE, RAM DIAMETER AND TONNAGE IN HYDRAULIC PRESSES, W. B. Updegraff. *Machinery*, vol. 22, no. 9, May, 1916. Chart showing relation between ram diameter, hydraulic pressure, and total pressure on ram of hydraulic jacks and presses.

Chart showing thickness of ram for various pressures per square inch and diameters. Compressive stress, 14,000 lb. per square inch.

Chart showing relation between pressure per square inch on ram diameter of ram and full load capacity of press.

Chart showing thickness of cylinder for various pressures per square inch and diameters. Tensile stress, 7000 lb. per square inch.

CIRCULAR SLIDE RULE FOR SHAFT DESIGNERS, Edwin S. Oberndorf. *Machinery*, vol. 22, no. 9, May, 1916, 1 p., 4 figs. Chart with condensed instructions for its use.

THE DISCHARGE FROM VERTICAL PIPES, C. E. Grunsky, *Western Engineering*, vol. 7, no. 5, May, 1916. Chart for computing discharge of water from vertical pipes when given, rise of water at the center above top of pipe.

SELECTED TITLES OF ENGINEERING ARTICLES

AERONAUTICS

THE SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS. Aeronautics, vol. 10, no. 131, April 19, 1916, 1½ pp.

THE WIND TUNNEL OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, J. S. Hunsaker. Technology Monthly, April and May, 1916.

BERICHTE DER DEUTSCHEN VERSUCHSANSTALT FÜR LUFTFAHRT, Wilhelm Hoff. Zeitschrift für Flugtechnik und Motorluftschiffahrt, vol. 7, nos. 5 and 6, March 25, 1916, 8½ pp., 17 figs.
Data on the tests of aeroplane wings.

INHERENT CONTROLLABILITY OF AEROPLANES, Leonard Bairstow. The Aeronautical Journal, vol. 20, no. 77, Jan.-March, 1916, 9 pp.

THE CHARACTERISTICS OF CERTAIN RESISTING SURFACES AND SCREWS, G. H. Bryan. The Aeronautical Journal, vol. 20, no. 77, Jan.-March, 1916, 7 pp.

THE 300 H. P. GREEN ENGINE. Aeronautics, vol. 10, no. 128, March 29, 1916, 1 p., illustrated.

NOTE ON THE DIMENSIONAL THEORY OF WIND TUNNEL EXPERIMENTS, Edgar Buckingham. Aerial Age, vol. 3, no. 6, April 24, 1916, 1½ pp.

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AIR MACHINERY

DIE PRESSLUFTWERKZEUGE DER MASCHINENFABRIK OBERSCHÖNEWEIDE, Ernst Preger. Der praktische Maschinen-Konstrukteur, vol. 49, no. 8, Feb. 24, 1916, 3½ pp., 10 figs.
Some German compressed-air tools.

COMMERCIAL METHODS OF TESTING AIR COMPRESSORS.—1, H. Addison. Mechanical World, vol. 59, no. 1531, May 5, 1916, ¾ p.

ACCIDENT TO A DIESEL ENGINE AIR COMPRESSOR. The Mechanical Engineer, vol. 37, no. 950, April 7, 1916, 1½ pp.

CONVEYING AND HOISTING

MODERN COAL AND COKE HANDLING MACHINERY: AS USED IN THE MANUFACTURE OF GAS, J. E. Lister. Journal and Transactions of the Society of Engineers, vol. 7, no. 4, April, 1916, 29 pp., 9 figs.

HANDLING MATERIALS IN MANUFACTURING PLANT, Robert L. Streeter. The Engineering Magazine, vol. 51, no. 2, May, 1916, 30 pp., 37 figs.

ENGINEERING MATERIALS

SURFACE TENSION EFFECTS IN THE INTERCRYSTALLINE CEMENT IN METALS AND THE ELASTIC LIMIT, F. C. Thompson. Paper read at Annual Meeting of Iron and Steel Institute, 1916, 38¼ pp., 8 figs.

WIRE AND WIRE ROPE. Journal of the Engineers' Society of Pennsylvania, vol. 17, no. 4, April, 1916, 9 pp., illustrated.

A NEW THERMO-ELECTRIC METHOD OF STUDYING ALLOTROPIC CHANGES IN IRON OR OTHER METALS, Carl Benedicks. Paper read at Annual Meeting of Iron and Steel Institute, 1916, 10 pp., 3 figs.

THE THEORY OF CORROSION OF STEEL, Leslie Aitchison. Paper read at Annual Meeting of Iron and Steel Institute, 1916, 14¼ pp., 4 figs.

INITIAL TEMPERATURE AND CRITICAL COOLING VELOCITIES OF A CHROMIUM STEEL, C. A. Edwards, J. N. Greenwood and H. Kikkawa. Paper read at Annual Meeting of Iron and Steel Institute, 1916, 27 pp., 18 figs.

A FEW EXPERIMENTS ON THE HARDNESS TESTING OF MILD STEEL, W. N. Thomas. Paper read at Annual Meeting of Iron and Steel Institute, 1916, 15 pp., 7 figs.

EARLY EXPERIMENTS ON THE RECALESCENCE OF IRON AND STEEL, A. Mallock. Paper read at Annual Meeting of Iron and Steel Institute, 1916, 5 pp., 4 figs.

THE INFLUENCE OF CARBON AND MANGANESE UPON THE CORROSION OF IRON AND STEEL. Robert Hadfield. Paper read at Annual Meeting of Iron and Steel Institute, 1916, 22½ pp., 10 figs.

EINFLUSS DER WÄRMEBEHANDLUNG AUF DIE KERBZÄHIGKEIT, KORNGRÖSSE UD HÄRTE VON KOHLENSTOFFARMEM FLUSSEISEN, A Pomp. Ferrum, vol. 13, no. 5, February, 1916, 13 pp., 10 figs.

Influence of heat-treatment on certain physical properties of low carbon steel (see abstract).

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CONTROLLING PIPING AND SEGREGATION, Dr. Henry M. Howe. The Iron Trade Review, vol. 58, no. 17, April 27, 1916, 5½ pp., 5 figs.

A NEW NON-FERROUS ALLOY DIAMOND HARD COPPER. Aerial Age, vol. 3, no. 6, April 24, 1916, ½ p.

HEAT TREATMENT OF STEEL, Geo. W. Pressel. Proceedings of the Canadian Railway Club, vol. 15, no. 3, March, 1916, 29½ pp.

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Variation of molecular friction of metals with temperature.

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EFFECT OF RUST ON THE RATE OF CORROSION, James Aston. Steel and Iron, vol. 50, no. 5, 4¼ pp.

FOUNDRY

THE MALLEABLE IRON PROCESS, Enrique Touceda. The Engineers' Club of Dayton Proceedings, vol. 2, no. 6, March, 1916, 27 pp.

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FUEL ECONOMY, William A. Bone. Journal of the Society of Chemical Industry, vol. 35, no. 7, April 15, 1916, 7½ pp.

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Smoke and soot prevention campaign in Munich, Germany.

THE PREPARATION OF STOKER COAL. Railway Age Gazette, vol. 60, no. 17, April 28, 1916, 1¼ pp., illustrated.

GASES

LES TOURBILLONS VIBRATOIRES. Le Génie Civil, vol. 68, no. 15, April 8, 1916, 2½ pp., 4 figs.
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The theory of motion of detritus and its application.

THE VISCOSITY OF OILS IN RELATION TO THE RATE OF FLOW THROUGH PIPES, R. T. Glazebrook, W. F. Higgins, J. R. Pannell. Journal of the Institution of Petroleum Technologists, vol. 2, no. 5, Dec., 1915, 40 pp., 16 figs.

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SUR LA MÉSURE DE LA PUISSANCE DES MOTEURS AU BANC-BALANCE, Maurice Le Pen et Jean Villey. Comptes Rendus des Séances de L'Académie des Sciences, vol. 162, no. 11, March 13, 1916, 2 pp.
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Practical problems in lubrication.

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MACHINE SHOP

NOTE ON THE RELATIONS BETWEEN THE CUTTING EFFICIENCIES OF TOOL STEELS AND THEIR BRINELL OR SCLEROSCOPE HARDNESSES, J. O. Arnold. Paper read at Annual Meeting of Iron and Steel Institute, 1916, 3 pp.

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AIR-LIFTS FOR DEEP-WELLS, W. H. Maxwell. Cassier's Engineering Monthly, vol. 49, no. 4, April, 1916, 14½ pp., 17 figs.

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